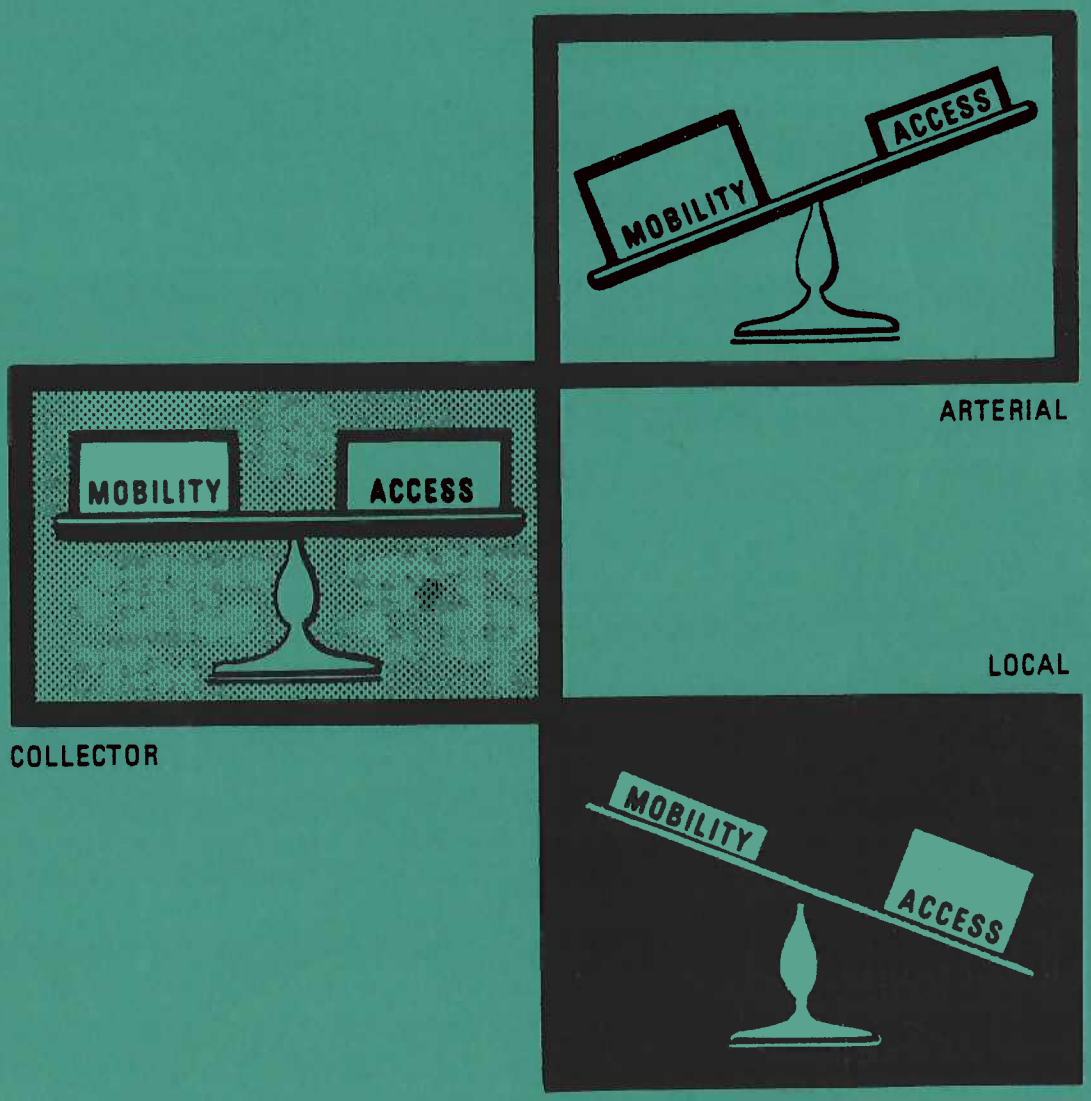
Highway Functional Classification

Concepts, Criteria and Procedures



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ADDENDUM

Highway Functional Classification - Concepts, Criteria and Procedures

This addendum supplements the manual, Highway Functional Classification - Concepts, Criteria and Procedures, March 1989, to provide more flexibility for classifying routes that cross urban boundaries and to provide specific criteria for including future or proposed routes.

Routes Crossing Urban/Rural Boundaries

The manual provides for rural routes (other than principal arterials) to be upgraded to a higher classification level when they cross an urban boundary. Although the principle is sound, rigid application has presented difficulties for some States. Accordingly, this addendum to the guidelines is intended to provide greater flexibility for deciding on an appropriate place for changing the functional classification when rural routes cross an urban boundary, taking into account changes in traffic conditions, the degree of urban development and other factors. Instead of automatically upgrading the functional classification of a rural route that crosses an urban boundary, the rural classification may be continued inside the urban boundary until there is a more logical and acceptable place for a change.

Future Routes

The manual discusses procedures for conducting a functional classification based on projected facilities and usage for some "future year"; however, the manual does not provide criteria for including future or proposed routes into a functional classification of existing facilities. Because the functional classification will support the designation of the National Highway System which is expected to include some future routes, this addendum establishes criteria for determining which future routes should be included in the functional classification of existing routes. Future routes should be functionally classified with the existing system if they are included in an approved short range improvement program and there is a good probability that the route will be under construction in the reasonably near future (up to 6 years). Where applicable, the same classification should be given to the future route and to the existing route that it will replace until the future route is constructed.

CONTENTS

SECTION I - INTRODUCTION

This reference manual includes sections on (1) concepts of functional highway classification and functional system characteristics and (2) suggested procedures for functional highway classification in rural, small urban and urbanized areas. The material herein is adapted from two previous FHWA manuals concerned with functional highway classification. The relationship of this manual to these previous documents is discussed below.

Two nationwide studies of functional highway classification were conducted during the period 1969-1971. The first of these, using criteria and procedures specified in the 1968 National Highway Functional Classification Study Manual, called for the functional classification of existing (1968) highways. The second study was carried out in accordance with procedures specified in the National Highway Functional Classification and Needs Study Manual (1970 to 1990) . This latter study used the same functional classes and basic functional criteria as the first study, but provided for the classification to be based on projected 1990 facilities and usage.

The Federal-Aid Highway Act of 1973 required the use of functional highway classification to update and modify the Federal-aid highway systems by July 1, 1976. This legislative requirement is still effective today. Also a number of States have adapted the functional classes and criteria from these studies for their own purposes. For both these reasons, a need has developed for a republication of the functional classification concepts and criteria that were expressed in the aforementioned manuals, without the reference to specific study requirements that pertained in those manuals.

The functional classes and their characteristics defined in this manual are, for the most part, identical to those in the predecessor manuals. Text has been reworded only to the extent necessary for consistency and clarity and to delete reference to the original studies. The discussion of functional classification concepts is taken intact from the earlier of the two manuals.

Also included herein is a discussion of suggested classification procedures for rural, small urban and urbanized areas, which derives from the predecessor manuals, relying largely, in fact, on their original wording. This approach therefore provides first, a description of suggested procedures for classifying an existing network, followed by procedural suggestions for developing an updated or "future year" classification.

Procedures for functional classification in urbanized areas should be developed within the framework of the continuing, comprehensive, and cooperative planning process carried out pursuant to Section 134 of Title 23, U.S. Code.

SECTION II - CONCEPTS, DEFINITIONS, AND SYSTEM CHARACTERISTICS

THE CONCEPT OF FUNCTIONAL CLASSIFICATION

Functional classification is the process by which streets and highways are grouped into classes, or systems, according to the character of service they are intended to provide. Basic to this process is the recognition that individual roads and streets do not serve travel independently in any major way. Rather, most travel involves movement through a network of roads. It becomes necessary then to determine how this travel can be channelized within the network in a logical and efficient manner. Functional classification defines the nature of this channelization process by defining the part that any particular road or street should play in serving the flow of trips through a highway network.

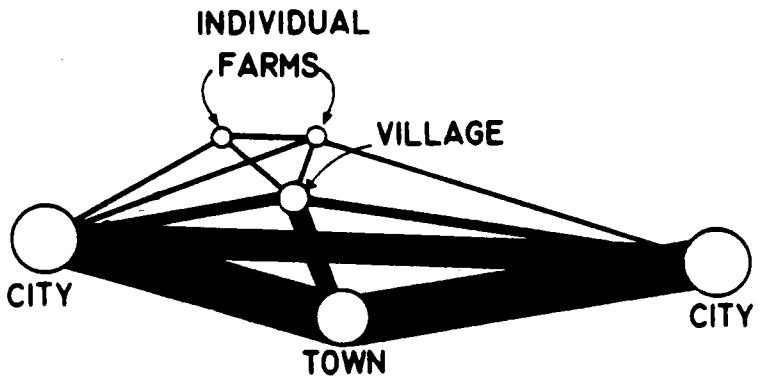
A schematic illustration of this basic idea is provided in Figure II-1. In the upper diagram, lines of travel desire are shown as straight lines connecting trip origins and destinations. Relative widths of lines indicate relative amounts of travel desire. Relative sizes of circles indicate relative trip generating or attracting power of the places shown. Since it is impractical to provide direct-line connections for every desire line, trips must be channelized on a limited road network in a logical and efficient manner. This can be done as shown in the lower diagram of Figure II-1. Note that the heavy travel movements are directly served or nearly so; and that the lesser ones are channeled into somewhat indirect paths. The facilities shown in the diagram have been labeled local, collector and arterial; terms which are descriptive of their functional relationships. Note particularly that this hierarchy of functional types relates directly to the hierarchy of travel distances which they serve.

A more complete (though still schematic) illustration of a functionally classified rural network is shown in Figure II-2. Since the cities and larger towns generate and attract a large proportion of the relatively longer trips, the arterial highways generally provide direct service for such travel. The intermediate functional category, the collectors, serves small towns directly, connects them to the arterial network, and collects traffic from the bottom-level system of local roads, which serves individual farms and other rural land uses.

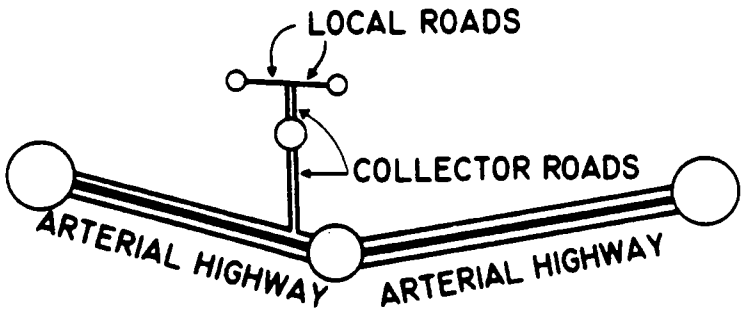
Although the above example has a rural setting, the same basic concepts apply in urban areas as well. A similar hierarchy of systems can be defined; however, because of the high intensity of land use and travel throughout an urban area, specific travel generation centers are more difficult to identify. In urban areas additional considerations, such as spacing, become more important in defining a logical and efficient network. A schematic illustration of a functionally classified urban street network is shown in Figure II-3.

FIGURE II-1

CHANNELIZATION OF TRIPS



(A) DESIRE LINES OF TRAVEL



(B) ROAD NETWORK PROVIDED

FIGURE II-2

SCHEMATIC ILLUSTRATION OF A FUNCTIONALLY CLASSIFIED RURAL HIGHWAY NETWORK

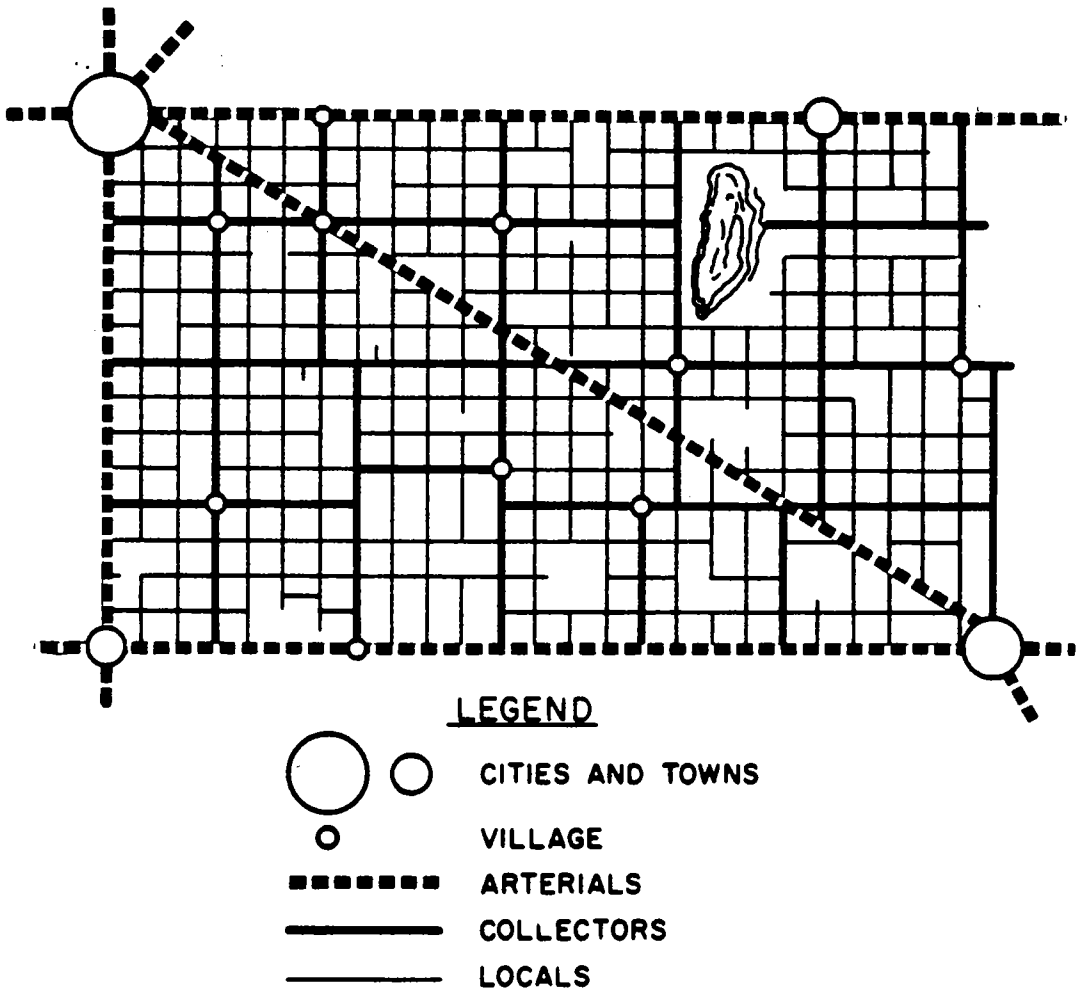
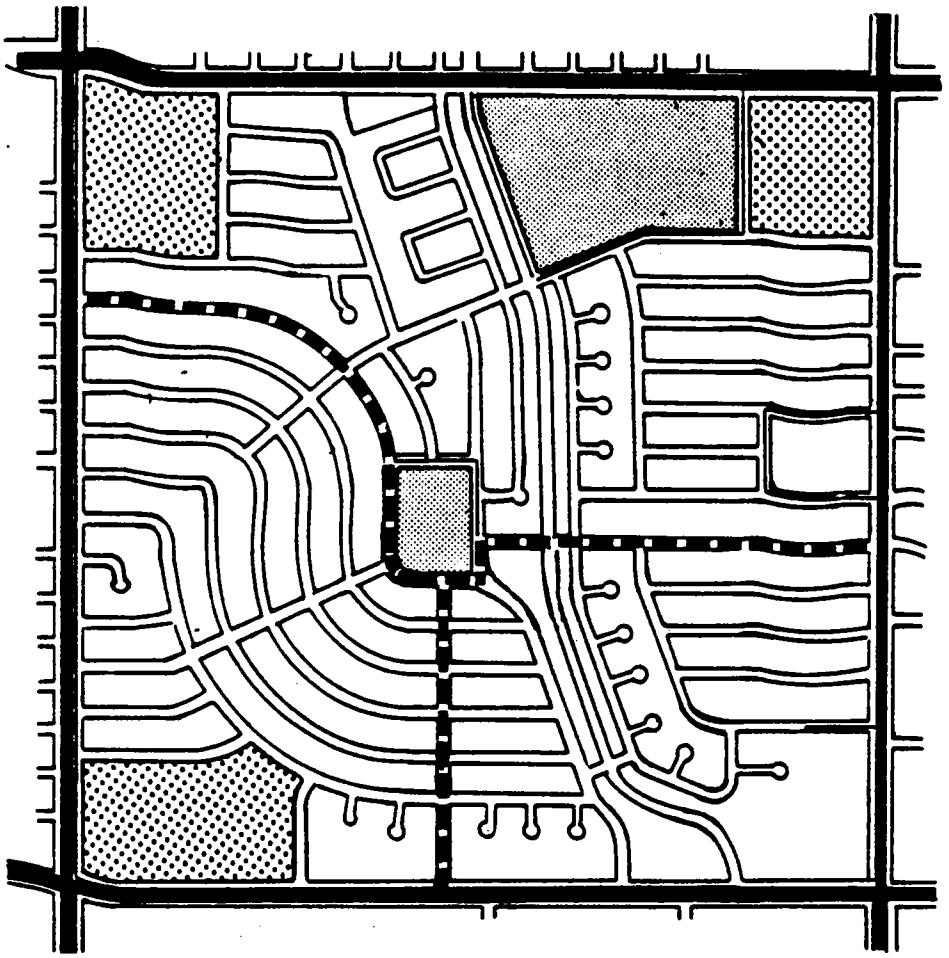


FIGURE II-3
SCHEMATIC OF A PORTION OF AN URBAN STREET NETWORK



Allied to the idea of traffic channelization is the dual role the highway network plays in providing (1) access to property, and (2) travel mobility. Access is a fixed requirement, necessary at both ends of any trip. Mobility, along the path of such trips, can be provided at varying levels, usually referred to as "level of service." It can incorporate a wide range of elements (e.g., riding comfort and freedom from speed changes) but the most basic is operating speed or trip travel time.

It was pointed out in the discussion of Figure II-1 that the concept of traffic channelization leads logically not only to a functional hierarchy of systems, but also to a parallel hierarchy of relative travel distances served by those systems. This hierarchy of travel distances can be related logically to a desirable functional specialization in meeting the access and mobility requirements. Local facilities emphasize the land access function. Arterials emphasize a high level of mobility for through movement. Collectors offer a compromise between both functions. This is illustrated conceptually in Figure II-4.

Functional classification can be applied in planning highway system development, determining the jurisdictional responsibility for particular systems, and in fiscal planning. These applications of functional classification are discussed in "A Guide for Functional Highway Classification." 1/

AREA DEFINITIONS

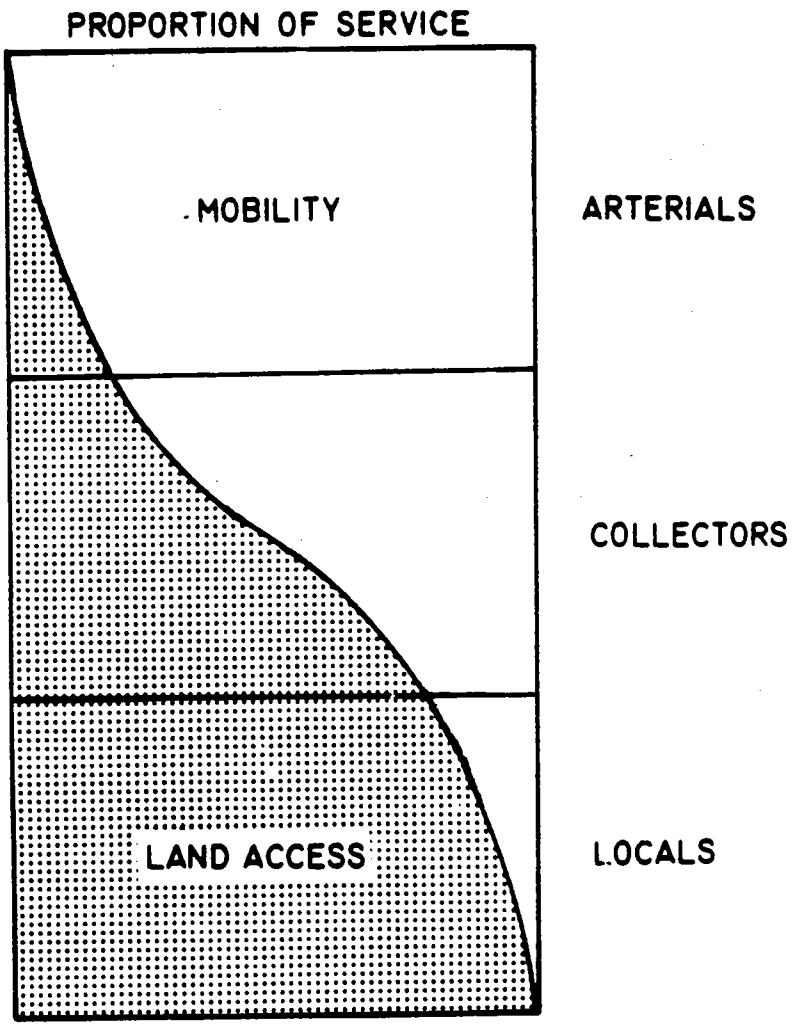
Urban and rural areas have fundamentally different characteristics as to density and types of land use, density of street and highway networks, nature of travel patterns, and the way in which all these elements are related in the definitions of highway function. Consequently, this manual provides for separate classification of urban and rural functional systems.

Experience has shown that extensions of rural arterial and collector routes provide an adequate arterial street network in places of less than 5,000 population. Hence urban classifications as discussed herein are considered in the context of places of 5,000 population or more.

1/ A Guide for Functional Highway Classification, prepared by a joint subcommittee of the American Association of State Highway Officials, the National Association of Counties, and the National Association of County Engineers (1964).

FIGURE II-4

RELATIONSHIP OF FUNCTIONALLY CLASSIFIED SYSTEMS IN SERVING TRAFFIC MOBILITY AND LAND ACCESS



Urban areas are defined in Federal-aid highway law (Section 101 of Title 23, U.S. Code) as follows:

> "The term 'urban area' means an urbanized area or, in the case of an urbanized area encompassing more than one State, that part of the urbanized area in each such State, or an urban place as designated by the Bureau of the Census having a population of five thousand or more and not within any urbanized area, within boundaries to be fixed by responsible State and local officials in cooperation with each other, subject to approval by the Secretary. Such boundaries shall, as a minimum, encompass the entire urban place designated by the Bureau of the Census."

For clarity and simplicity this reference manual will use the following terminology, which is consistent with the above definition.

Small urban areas are those urban places, as designated by the Bureau of the Census having a population of five thousand (5,000) or more and not within any urbanized area.

Urbanized areas are designated as such by the Bureau of the Census.

Rural areas comprise the areas outside the boundaries of small urban and urbanized areas, as defined above.

FUNCTIONAL SYSTEM CHARACTERISTICS

The following pages are devoted to separate descriptions of the characteristics of the basic functional systems and their subsystems for (1) rural areas, (2) urbanized areas, and (3) small urban areas. The primary functional categories used for each of the three area types are presented in Table II-1.

Table II-1 -- The Hierarchy of functional systems

Rural areas	Urbanized areas	Small urban areas
Principal arterials	Principal arterials	Principal arterials
Minor arterial roads	Minor arterial streets	Minor arterial streets
Collector roads	Collector streets	Collector streets
Local roads	local streets	Local streets

Since there is a wide variation in the characteristics and magnitude of service provided by each of these basic functional systems, further stratification of routes in these systems is prescribed to insure greater adaptability for subsequent use. In rural areas, routes on the principal arterial system are subclassified as Interstate and other principal arterials; and routes on the collector road system are subclassified as major collector roads and minor collector roads. In urbanized and small urban areas, the routes on the principal arterial system are subclassified as Interstate, other freeways and expressways, and other principal arterials.

Functional System for Rural Areas

Rural roads consist of those facilities that are outside of small urban and urbanized areas, as previously defined. They are classified into four major systems: Principal arterials, minor arterial roads, major and minor collector roads, and local roads.

Rural principal arterial system

The rural principal arterial system consists of a connected rural network of continuous routes having the following characteristics:

1. Serve corridor movements having trip length and travel density characteristics indicative of substantial statewide or interstate travel.

2. Serve 1/ all, or virtually all, urban areas of 50,000 and over population and a large majority of those with population of 25,000 and over.

3. Provide an integrated network without stub connections except where unusual geographic or traffic flow conditions dictate otherwise (e.g., international boundary connections and connections to coastal cities).

In the more densely populated States, this system of highway may not include all heavily traveled routes which are multi-lane facilities. It is likely, however, that in the majority of States the principal arterial system will include all existing rural freeways.

The principal arterial system is stratified into the following two subsystems:

Interstate System.--The Interstate System consists of all presently designated routes of the Interstate System.

Other principal arterials.--This system consists of all non-Interstate principal arterials.

Rural minor arterial road system

The rural minor arterial road system should, in conjunction with the principal arterial system, form a rural network having the following characteristics:

1. Link cities and larger towns 2/ (and other traffic

1/ The term "serve" is difficult to define on a national basis since it varies according to the size of the urban area, the functional system under consideration, and the effects of natural barriers where they exist. As a guide the rural principal arterial system may be considered to "serve" an urban area if the system either penetrates the urban boundary, or comes within 10 miles of the center of the place and is within 20 minutes travel time (off-peak periods) of the center of the place via a minor arterial highway. The rural minor arterial road system "serves" an urban area if the system either penetrates or comes within 2 miles of the urban boundary.

2/ The definition of a "large" town, in terms of population, cannot be arbitrarily determined in such a way as will fit all States. It can be determined in a given State during the classification process by building the system "from the top down," in terms of size of places served, and evaluating successive system increments on a diminishing returns basis, in terms of population service or traffic service. This is discussed in greater detail in Section III.

generators, such as major resort areas, that are capable of attracting travel over similarly long distances) and form an integrated network providing interstate and intercounty service.

2. Be spaced at such intervals, consistent with population density, so that all developed areas of the State are within a reasonable distance of an arterial highway.

3. Provide (because of the two characteristics defined immediately above) service to corridors with trip lengths and travel density greater than those predominantly served by rural collector or local systems. Minor arterials therefore constitute routes whose design should be expected to provide for relatively high overall travel speeds, with minimum interference to through movement.

Rural collector road system

The rural collector routes generally serve travel of primarily intracounty rather than statewide importance and constitute those routes on which (regardless of traffic volume) predominant travel distances are shorter than on arterial routes. Consequently, more moderate speeds may be typical, on the average.

In order to define more clearly the characteristics of rural collectors, this system should be subclassified according to the following criteria:

Major collector roads.--These routes should: (1) Provide service to any county seat not on an arterial route, to the larger towns not directly served by the higher systems, and to other traffic generators of equivalent intracounty importance, such as consolidated schools, shipping points, county parks, important mining and agricultural areas, etc.; (2) link these places with nearby larger towns or cities, or with routes of higher classification; and (3) serve the more important intracounty travel corridors.

Minor collector roads.--These routes should: (1) Be spaced at intervals, consistent with population density, to collect traffic from local roads and bring all developed areas within a reasonable distance of a collector road; (2) provide service to the remaining smaller communities; and (3) link the locally important traffic generators with their rural hinterland.

Rural local road system

The rural local road system should have the following characteristics: (1) Serve primarily to provide access to adjacent land; and (2) provide service to travel over relatively short distances as compared to collectors or other higher systems. Local roads will, of course, constitute the rural mileage not classified

as part of the principal arterial, minor arterial, or collector systems.

Extent of rural systems

The systems criteria above have been expressed primarily in qualitative, rather than quantitative terms. Because of varying geographic conditions (population density, spacing and size of cities, density and pattern of road network) it is not feasible to define uniform nationwide criteria on size of population centers, on trip length and traffic volume, or on spacing of routes, that would apply to all systems in all States. The results of classification studies conducted in many States throughout the country do, however, show considerable consistency in the relative extent of each system, expressed as a percentage of total rural road mileage.

Systems developed using the criteria herein are generally expected, in all States except Alaska and Hawaii, to fall within the percentage ranges shown in Table II-2. The higher values in Table II-2 would apply to States which have a less extensive total road network than is typical of States of similar population density. In States having a more extensive total network, the lower values would be expected to apply. The range of percentages for rural collectors is for the total mileage of both major and minor collector roads, and applies to the statewide rural mileage totals; the percentage in any particular county may vary considerably from the statewide average. Areas having an extensive grid pattern of roads will usually have a lesser percentage of collectors than areas wherein geographic conditions have imposed a restricted or less regular pattern of road development.

Table II-2 -- Guidelines on extent of rural functional systems

System	Range (percent)	
	VMT	Miles
Principal arterial system	30 - 55	2 - 4
Principal arterial plus minor arterial road systems	45 - 75	6 - 12*
Collector road system	20 - 35	20 - 25
Local road system	5 - 20	65 - 75

* With most States falling in the 7-10 percent range.

Functional Systems in Urbanized Areas

The four functional systems for urbanized areas are urban principal arterials, minor arterial streets, collector streets, and local streets. The differences in the nature and intensity of

development between rural and urban areas cause these systems to have characteristics that are somewhat different from the correspondingly named rural systems.

Urban principal arterial system

In every urban environment there exists a system of streets and highways which can be identified as unusually significant to the area in which it lies in terms of the nature and composition of travel it serves. In smaller urban areas (under 50,000) these facilities may be very limited in number and extent and their importance may be primarily derived from the service provided to travel passing through the area. In larger urban areas their importance also derives from service to rural oriented traffic, but equally or even more important, from service for major movements within these urbanized areas.

This system of streets and highways is the urban principal arterial system and should serve the major centers of activity of a metropolitan area, the highest traffic volume corridors, and the longest trip desires; and should carry a high proportion of the total urban area travel on a minimum of mileage. The system should be integrated, both internally and between major rural connections.

The principal arterial system should carry the major portion of trips entering and leaving the urban area, as well as the majority of through movements desiring to bypass the central city. In addition, significant intra-area travel, such as between central business districts and outlying residential areas, between major inner city communities, or between major suburban centers should be served by this system. Frequently the principal arterial system will carry important intraurban as well as intercity bus routes. Finally, this system in small urban and urbanized areas should provide continuity for all rural arterials which intercept the urban boundary.

Because of the nature of the travel served by the principal arterial system, almost all fully and partially controlled access facilities will be part of this functional system. However, this system is not restricted to controlled access routes. In order to preserve the identification of controlled access facilities, the principal arterial system is stratified as follows: (1) Interstate, (2) other freeways and expressways, and (3) other principal arterials (with no control of access).

The spacing of urban principal arterials will be closely related to the trip-end density characteristics of particular portions of the urban areas. While no firm spacing rule can be established which will apply in all, or even most circumstances,

the spacing of principal arterials (in larger urban areas) may vary from less than one mile in the highly developed central business areas to five miles or more in the sparsely developed urban fringes.

For principal arterials, the concept of service to abutting land should be subordinate to the provision of travel service to major traffic movements. It should be noted that only facilities within the "other principal arterial" system are capable of providing any direct access to adjacent land, and such service should be purely incidental to the primary functional responsibility of this system.

Urban minor arterial street system

The minor arterial street system should interconnect with and augment the urban principal arterial system and provide service to trips of moderate length at a somewhat lower level of travel mobility than principal arterials. This system also distributes travel to geographic areas smaller than those identified with the higher system.

The minor arterial street system includes all arterials not classified as a principal and contains facilities that place more emphasis on land access than the higher system, and offer a lower level of traffic mobility. Such facilities may carry local bus routes and provide intra-community continuity, but ideally should not penetrate identifiable neighborhoods. This system should include urban connections to rural collector roads where such connections have not been classified as urban principal arterials.

The spacing of minor arterial streets may vary from 1/8 - 1/2 mile in the central business district to 2 - 3 miles in the suburban fringes, but should normally be not more than 1 mile in fully developed areas.

Urban collector street system

The collector street system provides both land access service and traffic circulation within residential neighborhoods, commercial and industrial areas. It differs from the arterial system in that facilities on the collector system may penetrate residential neighborhoods, distributing trips from the arterials through the area to the ultimate destination. Conversely, the collector street also collects traffic from local streets in residential neighborhoods and channels it into the arterial system. In the central business district, and in other areas of like development and traffic density, the collector system may include the street grid which forms a logical entity for traffic circulation.

Urban local street system

The local street system comprises all facilities not on one of the higher systems. It serves primarily to provide direct access to abutting land and access to the higher order systems. It offers the lowest level of mobility and usually contains no bus routes. Service to through traffic movement usually is deliberately discouraged.

Extent of mileage and travel on urban systems

Table II-3 contains guideline ranges of travel volume (VMT) and mileage of each of the four functional systems for urbanized areas. Systems developed for each area using the criteria herein will usually fall within the percentage ranges shown.

Table II-3 -- Guidelines on extent of urban functional systems

System	Range (percent)	
	VMT	Miles
Principal arterial system	40 - 65	5 - 10
Principal arterial plus minor arterial street systems	65 - 80	15 - 25
Collector street system	5 - 10	5 - 10
Local street system	10 - 30	65 - 80

Functional System for Small Urban Areas

The systems and their characteristics listed for urbanized areas are also generally applicable to small urban areas. The basic difference is that, by nature of their size, many small urban areas will not generate internal travel warranting urban principal arterial service.

Thus the principal arterial system for small urban areas will largely consist of extensions of rural arterial into and through the areas. In many instances, these extensions will be located so as to relieve critical sections of the street system while providing efficient movement of travel around (e.g., bypasses) and through the area. The larger urban areas within this population group, particularly those above 25,000 population, may have major activity centers which warrant principal arterial service in addition to that provided by extensions of rural arterials.

The characteristics for the minor arterial street systems, collector street systems, and local street systems in small urban areas are similar to those for urbanized areas.

Special Urban-Rural Identification

The criteria in this section define urban and rural streets and highways according to their functional character. To assure continuity of the rural arterial systems through urban areas, it is desirable to doubly identify (as indicated below) the urban arterials which form connecting links of the rural arterials. The term "connecting links" means those urban routings which will provide rural-to-rural continuity for the rural arterial systems. A connecting link may traverse the urban area from one boundary to another, or may simply connect to another previously delineated connecting link. (The mileage of any connecting link should not be included more than once.) The necessary continuity may be provided by loop or bypass routes. It is recommended that the identification be made after both the urban and rural functional classifications have been accomplished.

As specified in the systems characteristics in this section, connecting links for the rural principal and minor arterial systems will be on the urban principal arterial system (continuity for the rural Interstate will, of course, be provided by urban Interstate). Connecting links for rural principal arterials should be identified prior to selecting those for minor arterials. The routing of the connecting link for a rural principal arterial should normally be fairly direct, while that for a rural minor arterial may involve some indirection of travel.

The following categories are to be used in identifying these connecting links on the urban principal arterial system:

1. Other freeways and expressways:

   Connecting links of non-Interstate rural principal arterials
   Connecting links of rural minor arterials

2. Other urban principal arterials:

   Connecting links of other rural principal arterials
   Connecting links of rural minor arterials

Classification Criteria for Alaska, Hawaii, and Puerto Rico

The classification of rural and urban systems in Alaska, Hawaii, and Puerto Rico can generally be consistent with the functional system characteristics described in the preceding sections. However, there may be roads on small islands or in other areas that are isolated from the remaining parts of the State or Commonwealth, and none of these roads may meet the criteria for classification as arterial because of the absence of long-distance,

through trips. Conversely, there may be undeveloped areas that have very few miles of collector and local roads. Thus, because of the considerably different geographic conditions existing in these areas as compared to the other 48 States, the systems extent for the rural functional classes may vary from that shown in Table II-2. The systems extent for the urban functional classes should be fairly consistent with that shown in Table II-3.

SECTION III - SUGGESTED PROCEDURES FOR RURAL, SMALL URBAN AREA AND URBANIZED AREA CLASSIFICATION

INTRODUCTION

This section suggests procedures for classifying all roads and streets into functional systems for rural, small urban and urbanized areas, based on the most logical use of the existing facilities 1/ to serve present travel. Separate procedures are presented for rural, small urban and urbanized areas. In addition, for each of these areas, procedures are given for a functional classification of existing conditions. Also, for each of those areas, procedures are given for a functional classification based on projected facilities and usage for some "future year."

While the basic concepts and functional criteria for the development of a "future year" functional classification plan are the same as those for a functional classification of existing facilities, it will differ in two basic respects: (1) It should be based on projected "future year" population, land use and travel; and (2) it will include, in addition to existing facilities, such projected totally new facilities as will be needed to serve "future year" land use and travel. Some of this new mileage will consist of new streets in expanding urban areas.

Beltways and bypasses in smaller cities will constitute another major category of new mileage. In addition, some new routes may be needed to serve planned and committed new recreational areas or new towns. A final category of additional, though in one sense not "new," facilities will be those representing relocation of existing facilities, in cases where adequate standards cannot be provided on the original location, or where an existing routing is excessively circuitous.

In developing a "future year" classification, consideration should be given to the impact of foreseeable developments in other modes of transportation. On statewide systems, especially in heavily traveled intercity corridors, the influence of highspeed rail service and improved air service can be estimated through travel forecasts to the extent they are quantifiable. Such influences will probably have more impact on the needed capacity of highway facilities than on the actual system configuration.

1/ Note: Two special cases should be treated in the following manner: One-way streets should be classified individually, and their mileage and travel accumulated on an individual basis, not in pairs. Frontage roads should be classified independently of the controlled-access facility on which they abut. The classification of frontage roads, based upon the criteria presented in this manual should normally be in the collector or local category.

"Future Year" - Functional Classification

When a functional classification is made based on a "future year," a projection of population should be made.

As was pointed out in Section II, the identification of population centers is essential in the functional classification concept. When a "future year" functional classification is made, population estimates for that "future year" should be prepared for all areas that are expected to be urban as well as for the remaining rural subareas.

Each populated place presently containing less than 5,000 persons and not included within the delimited boundary of a "future year" urbanized area, should be examined to determine whether its anticipated population growth to the "future year" will result in its classification as a small urban area. In addition, certain presently rural areas (i.e., suburban development, new towns, etc.) should be examined to determine those which will qualify as small urban areas due to expected population increases by the "future year."

The base for a "future year" population should be the most recent Decennial Census. As applicable, the total State regional and national "future year" populations should be given consideration when estimating populations of the individual urbanized and small urban areas in order that the estimates will be reasonable and consistent. Consequently, in making "future year" urban estimates, it will be necessary to develop them coincidently with and in relation to the total "future year" State population projections and the projections for the remaining rural population (including those places from 2,500 to 4,999 population).

A considerable amount of population data is available in the States through the urban transportation studies, from previous functional classification studies (see page I-1), and from agencies preparing current population estimates for the various States.

Because of the variety of kinds of population forecasts and sources of forecasting advice and assistance that are available to the States, no single forecasting procedure is suggested in this manual. Of foremost importance in any procedure is the maintenance of a sound overall perspective. Specifically, the aggregate of individual place projections must stand the test of reasonableness in terms implied overall trends for urbanized areas, for small urban areas by size group, and for rural area density.

To assure reasonable distribution of total projected population by the above categories an iterative approach with feedback tests is necessary, particularly, in some States, when a very large proportion of the total population growth will occur in urbanized areas. Proportionally small variances in forecasts for these places can have a disproportionate effect on residual values applicable to small urban places and rural areas. Hence a step-down residual forecasting procedure without feedback should be avoided.

CLASSIFICATION PROCEDURES FOR RURAL SYSTEMS

Rural classification procedures apply to those areas outside of urbanized or small urban area boundaries, although many rural routes particularly arterials, continue into or through the latter areas.

Identifying and Ranking Population Centers and Other Travel Generators

The procedure for rural functional classification, as outlined in this subsection, initially involves connecting traffic generators in such a manner as to logically channelize the trips on the road network. Since most trips begin or end in a city of town, population centers are the primary traffic generators considered. However, since travel is also generated by recreation areas, such as National parks, ski resorts, lakes, and beaches, that have little resident population, instructions are included here for comparing the importance of these areas to that of a city or town.

The population of a place generally reflects its capacity for generating and attracting travel. Socio-economic factors, such as trade, employment, etc., may also indicate the importance of a place in relation to intercity travel. Urban areas of similar population and economic activity (and consequently travel generation and attraction) should be identified and service provided to them by routes of the same statewide functional system.

Ranking of population centers, usually on the basis of population is an initial step in the classification process. Available socio-economic data (e.g., sales tax receipts, retail trade, employment, etc.) may be used along with population in this ranking if the State feels that such factors are significant for the area under study. Each urban area should be treated as one center, even if several jurisdictional units are involved and even if part of the population is in an adjoining State.

Since this ranking process is one of the means of determining the population centers for which service by a particular functional system is to be provided, all places thought qualified for service by the major collector road or any higher system should be ranked.

Major travel generators other than cities, such as recreation areas (National and State parks, State fairgrounds, ski resorts, lakes, beaches, etc.) and military installations should be treated separately during the ranking process because of their unique, predominant land activity. Usual trip generation yardsticks, such as population, employment, and related factors which measure the socio-economic status of the area and its population, are not applicable to such generators because of their atypical travel generation potential. For example, National parks and State fairgrounds contain little or no resident population and, in general, contain no commercial or industrial activity other than facilities to serve tourists. Hence, these centers require that other data be employed during the ranking process.

For purposes of functional classification, the annual number of visitors to such a recreation area can be equated to an urban area's population as shown in Figure III-1. The recreation area can then be grouped with population centers of similar trip generation potential, and service provided by the same functional system.

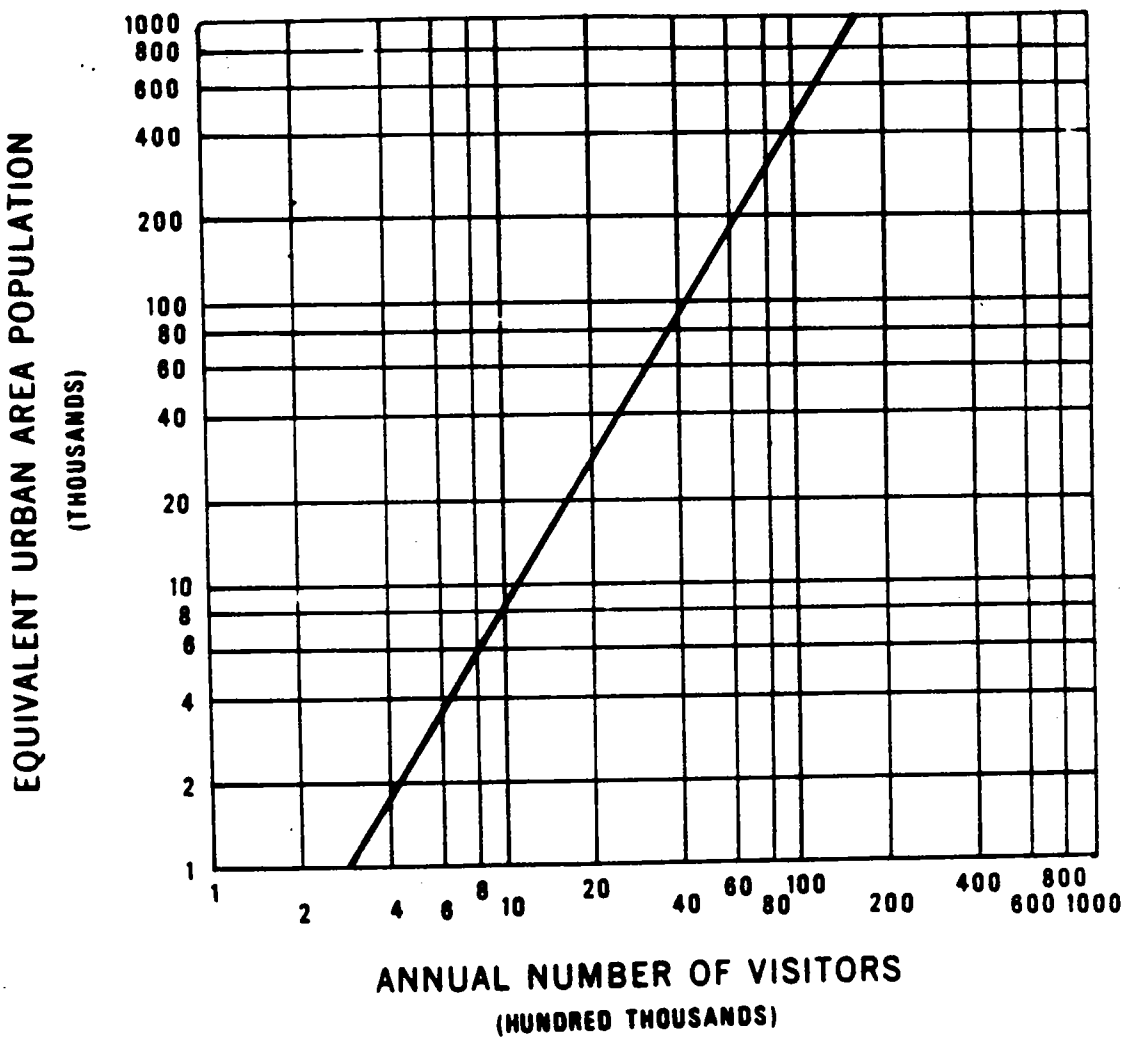
Where several recreation areas are located close together and can be served by only one possible route, such as on a coastal peninsula or in a mountainous area, the equivalent populations may be combined in ranking the area.

Visitation data for recreation areas administered by the State and Federal Governments should be available from the Bureau of Outdoor Recreation liaison officer in each State.

The importance of recreation and other generators can be inferred from traffic flow data if there are no other data available for ranking purposes.

FIGURE III-1

VISITATION VS. EQUIVALENT POPULATION FOR RANKING RECREATION GENERATORS



Classification of Rural Systems

As stated earlier, the procedure for rural functional system classification initially involves connecting traffic generators in such a manner as to logically channelize the trips on the road networks. The preceding discussion explains procedures for ranking population and other centers of traffic generation. These procedures do not eliminate judgment from the classification process, but when used as a guide they do help to apply judgment in a sound and orderly fashion.

Rural principal and minor arterial systems

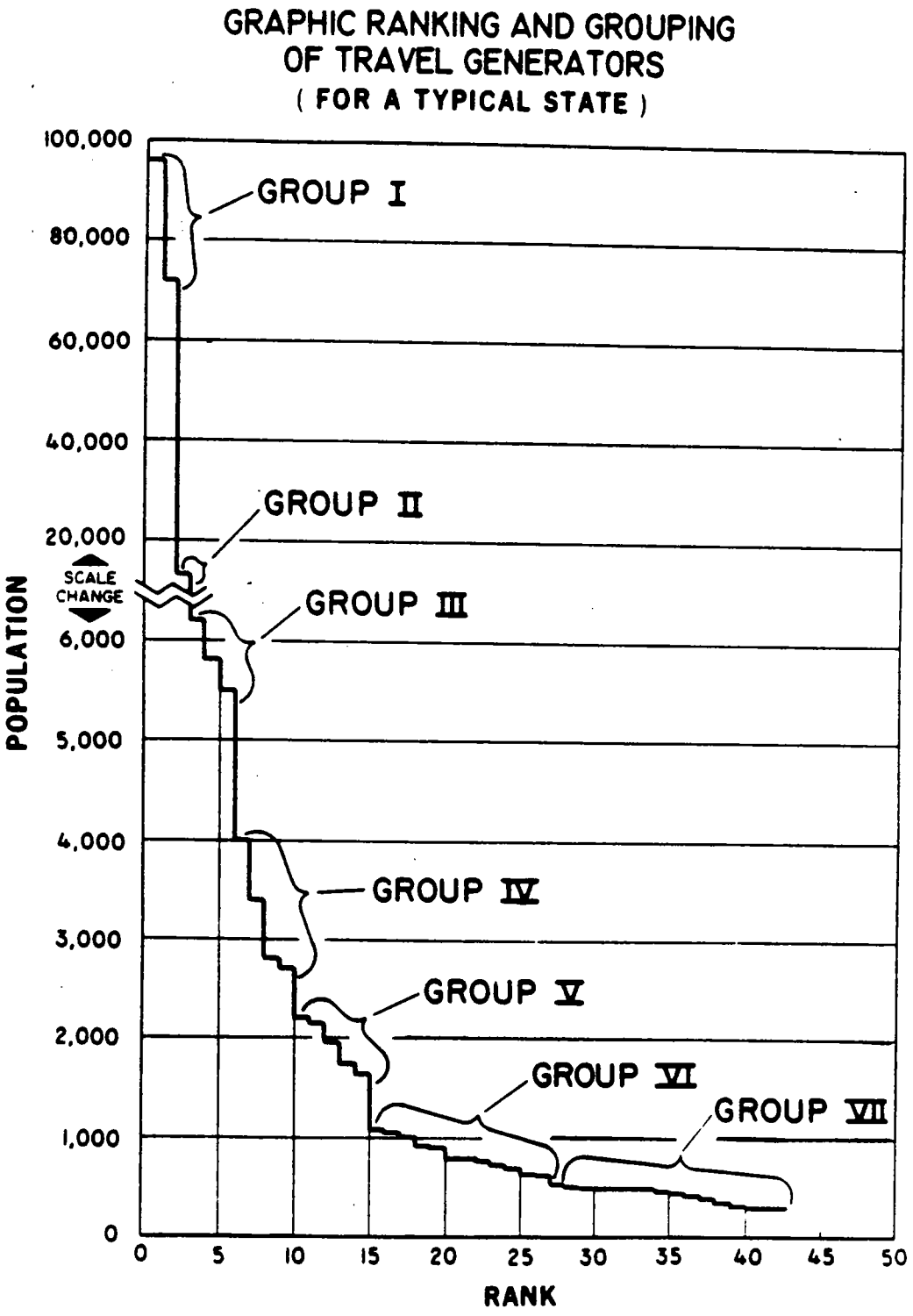
The procedures for functional classification of rural roads into the principal arterial and minor arterial systems are described in the following enumerated steps:

1. One of the initial steps in the classification of rural routes is the preparation of road network maps. Maximum use should be made of existing maps although reference to administrative or jurisdictional systems should not be considered in the classification process.

2. Rank travel generators as described in the immediately preceding pages. Plot generators graphically, in order to ranking, and divide into groups, with centers of similar rank in each grouping, as illustrated in Figure III-2. While no hard and fast rules apply, six to eight groupings will usually be typical. Too many are better than too few, particularly toward the lower end of the scale. This ranking and grouping will aid in determining which centers qualify for minor arterial service or major collector service, and which will be adequately served by minor collector roads.

3. Identify pertinent travel generators in adjoining States. Judgement should be used in selecting the centers to be included. Larger out-of-State generators have traffic attraction relationships over a considerable distance while smaller out-of-State generators may be of influence only when close to the State boundary. Fit these selected out-of-State generators into the appropriate size group determined for the in-State generators in Step 2 above.

FIGURE III-2


GRAPHIC RANKING AND GROUPING
OF TRAVEL GENERATORS
(FOR A TYPICAL STATE)
100,000
80,000
60,000
40,000
20,000
SCALE CHANGE
6,000
5,000
4,000
3,000
2,000
1,000
0
POPULATION
GROUP I
GROUP II
GROUP III
GROUP IV
GROUP V
GROUP VI
GROUP VII
0
5
10
15
20
25
30
35
40
45
50
RANK

4. Develop a map symbol (for example, a simple open or lightly shaded circle) for each size group of travel generators, with the size of the map symbol indicating the population range of centers in the group. Plot the generators on a statewide map. A tracing overlay superimposed on the statewide road map is recommended. The few pertinent out-of-State generators which may fall outside the State map can be dealt with by plotting them on a regional map. Once the appropriate routings to the out-of-State generators have been selected, they can be shown on the statewide map by placing arrows at the State line.

5. Delineate urbanized area boundaries on the statewide map as accurately as practicable. (Subsequent accurate mileage determinations will probably require reference to large-scale maps, particularly when measuring mileages within urban limits.)

6. Delineate all presently designated routes of the Interstate highway system.

7. Select the remaining rural principal arterial routes and, following that, the rural minor arterial routes, in a general sequence that will "work down from the top" to reflect a gradation of the following route characteristics, considered in combination: (a) Size of travel generators connected; (b) predominant travel distances served; and (c) size of tributary area or "travel shed" served. The term "in sequence" does not mean an exact numerical ranking of routes since in many cases several routes may be deemed nearly equal in the above characteristics.

The size of the travel generators being connected has been visually symbolized on the map. The predominant travel distance and size of the tributary area or "travel shed" can be inferred visually from the size of centers served, their spacing and orientation, and the size and shape of traffic flow bands of traffic maps.

Judgment must be exercised in determining which, among all possible connections, should be made, especially when dealing with medium-sized and smaller centers. It will be helpful to keep in mind that this procedure is based on an indirect and inferential approach to the traffic attraction between centers. Therefore, the traffic flow map will help to indicate which, of all possible connections, is the most significant for the level or size of center being considered. When medium and small-sized centers are under consideration, a connection with the nearest larger center is usually more significant than a connection with a center of equal size. Where alternatives are equal in terms of mileage, the most heavily traveled and the better improved route should normally be selected.

The termini for the routes being added to each system should be selected so that a continuous system is always maintained (i.e., each route is connected to routes of the same or higher level system).

8. Determine the total length of the rural principal arterial system in accordance with the system characteristics and the guide on system mileage extent in Section II, page II-11.

9. Determine the lower size limit of population centers to be served as a group by the minor arterial system. In the criteria for this system, the diminishing returns concept is mentioned. This means that in adding routes to a system, a point is reached at which the rate of increase in mileage begins to exceed markedly the rate of increase of highway service, indicating that the lower limit of the system under consideration has been determined. Figure III-3, on which cumulative system mileage has been plotted against cumulative service as measured by vehicle-miles of travel, is an illustration of this concept.

The concept illustrated in Figure III-3 can be applied during the classification process by visual evaluation of the system map in conjunction with basic data on traffic flow and population. The following considerations, used in conjunction, should apply. First, as indicated in Section II, page II-11, a combined mileage of rural principal arterial and minor arterial classes of between 7 and 10 percent of total rural mileage is the normal maximum extent. Considering this as the limit being approached, then: (1) Would adding routes to serve a next group of smaller generators result in adding a considerable mileage of routes carrying, as a group, substantially less traffic than routes already added? (2) Is the radius of traffic attraction of this next group of smaller generators, as implied by their size, their distance from larger generators, or by traffic flow data, substantially less than that of places already served? If the answer to either question is yes, then a logical lower limit of the minor arterial system has been reached, as far as service travel generators is concerned.

10. Add such other routes to the minor arterial system as are required by the defined system characteristics. Such routes will include:

(a) Service to corridor movements with trip lengths and volumes equivalent to those of routes already added, as determined from traffic flow maps.

(b) Service to all areas of the State, with spacing of routes at reasonably consistent intervals, as tempered by consideration of population density.

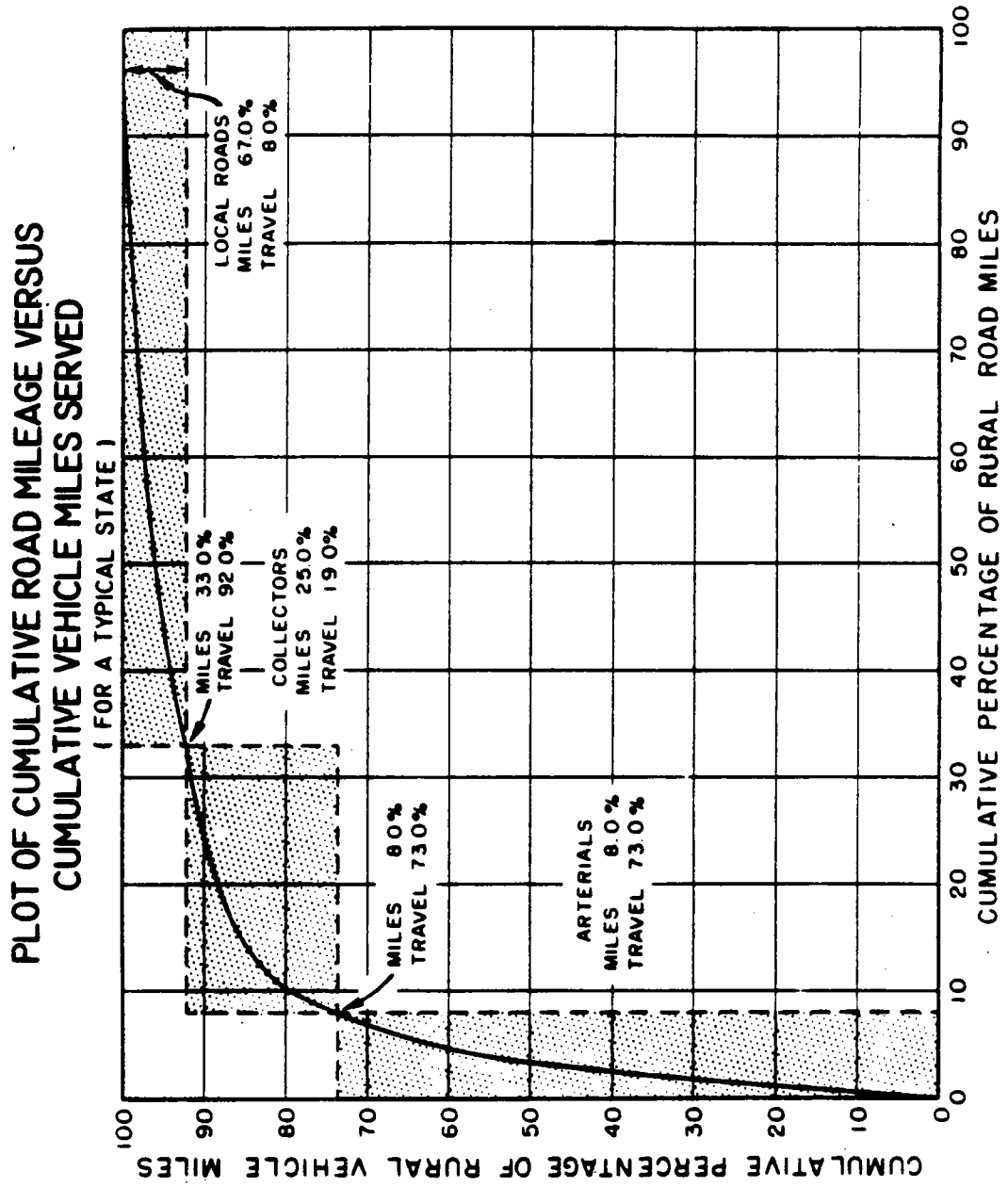

PLOT OF CUMULATIVE ROAD MILEAGE VERSUS
CUMULATIVE VEHICLE MILES SERVED
(FOR A TYPICAL STATE)
LOCAL ROADS
MILES 67.0%
TRAVEL 8.0%
COLLECTORS
MILES 25.0%
TRAVEL 19.0%
ARTERIALS
MILES 8.0%
TRAVEL 73.0%
MILES 33.0%
TRAVEL 92.0%
MILES 8.0%
TRAVEL 73.0%
CUMULATIVE PERCENTAGE OF RURAL VEHICLE MILES
CUMULATIVE PERCENTAGE OF RURAL ROAD MILES
0
10
20
30
40
50
60
70
80
90
100

FIGURE III-3

(c) Such additions as are clearly needed for adequate statewide continuity (but only where significant travel patterns serve to justify them).

11. Inclusion in the system of additional alternative routes is a problem that will occasionally arise. In most cases a single connection between two centers is all that is needed. Some instances where alternative routes may have to be considered are:

(a) Where two apparently alternative routes are separated by geographic barriers and each is needed for minor arterial service to some qualified intermediate center or for connection to another intersected minor arterial route.

(b) Where one major facility is a parkway from which commercial vehicles are excluded.

(c) Where the total traffic volume cannot practicably be handled by one facility.

(d) Where one facility is a toll road.

"Future Year" Classifications: Studies conducted over the years have indicated a large degree of stability in the routes and corridor locations of arterial systems. To a considerable extent, centers of the lower size range of places served by these systems (especially minor arterial) are not undergoing great or rapid change. Furthermore, considering mere growth, per se; if all centers were growing in proportion, without causing significant shifts in travel linkages, such growth would not affect the functional relationships in the road network. There will, however, be instances where smaller cities and towns, due to unique circumstances of location or activity, will be anticipated to undergo substantial growth. The same will apply, probably in greater degree, to other travel generators, especially recreation centers. These rapidly expanding generators will be of principal interest in reviewing the updated ranking of generators.

Generators other than population centers should be involved in the ranking of generators. Both in regard to population projections and in projecting these other generators, statewide and regional development agencies should be contacted to obtain information on development trends, available socio-economic forecasts, and statewide and regional development plans.

Visitation forecasts for important recreation centers should be obtained, or made if not available. Projections of visits should be reviewed to assure that individual forecasts are realistic in terms of use potential and that projected statewide totals reflect a growth rate consistent with overall travel growth. Figure III-1, page III-5 may be used to obtain equivalent population to use in the ranking process.

Rural collector system

The step-by-step procedure just described for laying out the rural principal arterial and minor arterial systems can be extended in a qualitative sense, to the development of the rural collector system. However, precise quantitative data as to size of traffic generators and amount of traffic movement are usually not available to the same degree at the collector level. Also, population density and distribution and basic road patterns vary widely at this level. Accordingly, the procedure as described here is somewhat more generalized than that described for the higher systems. In any case, it should be borne in mind that what is being laid out is the backbone network of traffic circulation at the county or local level.

Before selecting any routes for the rural collector system a preliminary visual and mental assessment of the entire local picture should be made, considering the following:

1. Location of population centers (including county seats) not already served by the higher systems.

2. Location of important local traffic generators other than population centers: consolidated schools, shipping points, county parks, etc. Aerial photographs, where available, should prove helpful in locating these local traffic generators.

3. Location of any heavier-than-average corridor movements within the county, from traffic flow data.

4. Location of existing freeway interchanges or important river crossings that may be key location controls with regard to the collector system.

5. Rural population and land-use distribution within the county as regards uniform or nonuniform density of development.

Selection of major collector routes.--In many instances, selection of a few major collector routes can be made and shown on the statewide map which has been used to delineate the arterial systems. This is a practical matter of working with whatever map offers the most convenient scale. Completion of the collector classification, however, should be done on maps of county scale, preferably those of the county highway planning series. A mosaic of maps of the county being classified and the bordering counties will be helpful in determining the function of routes crossing the county line. The designated principal arterial and minor arterial systems and any collector routes already designated on the statewide map should be transferred to the county map before any additional routes are selected. The major collector routes should then be selected to accomplish the following:

1. Connect the county seats and the larger population centers not served by the higher systems with such systems and/or directly with nearby larger population centers served by those higher systems.

2. Link the more important local traffic generators with nearby population centers or with this or a higher system.

3. Serve corridor movements with traffic volumes and trip lengths comparable to those of major collector routes already selected.

Selection of minor collector routes.--The routes selected up to this point serve to connect population centers and other traffic generators of like magnitude. However, there will be many areas with clustered residents at considerable distance from the previously selected systems. Within reasonable economic limits, minor collector or "spacer" routes should be designated to serve these areas, interconnect the small communities, and link the locally important traffic generators with their rural hinterland.

These "spacer" routes should be selected so as to provide approximately equal distance between arterial or collector routes for equal rural population densities so that equitable service is provided to all rural areas of the State. The approximate population density within each area bounded by major collector or arterial routes can be determined, either from census data or by an approximate house count from the county highway map, and the existing spacing of routes already selected can be measured. Areas with poor service can then be identified by comparing those data with a table of desirable collector spacing (miles between routes) versus population density (people per square mile) and additional routes selected and added to the collector system where necessary.

Future year classification.--In most counties there should be a substantial degree of stability over time in the extent and location of rural collector routes. There will, of course, be changes brought about by (a) change urban-in-fact boundaries, (b) reclassification of arterials superseded by relocations; even in counties where the rural environment remains little changed, and, (c) reclassification of roads presently functioning as collectors to local classification due to the normal diversion and increased channelization of traffic on to one facility following a highway improvement.

Probable changes in land use which would significantly affect the classification plan should be forecast wherever possible. Such changes are most predictable where substantial recreation developments are being planned or where other changes in basic economic activity can be firmly projected, including some assurance as to probable activity sites. Plans and forecasts of State and local agencies should be sought out where available. It is not suggested here, however, that all local plans be uncritically accepted. They should be compared with overall State forecasts for reasonableness.

Local rural roads

The remaining rural mileage not otherwise classified as principal arterial, minor arterial, or collector should be assigned to the rural local road system.

For future year classifications there will generally be a reduction in rural local mileage brought about by changed urban boundaries. There may be some growth of rural local mileage, particularly for projected recreation, industrial and rural residential developments.

CLASSIFICATION PROCEDURES FOR SMALL URBAN AREAS

This subsection includes the procedures for developing functionally classified street and highway systems in small urban areas. The systems so developed should be consistent with the system characteristics discussed in Section II.

Determine and map the urban area boundary

The boundary delimiting the area that is urban-in-fact, should be plotted on an existing map of the small urban area. Existing land-use maps or recent aerial photographs may be used to help in locating this boundary. Where neither of these are available, the division line between urban and rural development can be determined through aerial or ground reconnaissance; or officials of the town under study may help to locate this line from their knowledge of local development.

Prepare road network map

The street and highway network should be updated on the map used in selecting the urban boundary by adding any facilities open to traffic that are not shown on the original map. New routes can be sketched on the map in their approximate location.

Identify and map land service characteristics

Major traffic generators, land use patterns, and the points at which rural arterial and collector routes intercept the urban boundary should be identified and shown on the map of the area. Recent aerial photographs should prove very useful in identifying the major traffic generators and land use patterns.

Classify the highway and street network

Classify the highway and street network in accordance with the system characteristics discussed in Section II, and in relation to the land service characteristics described above. In accordance with logical system continuity considerations, select first the principal arterial system, followed by minor arterials, and finally collectors.

As a first step in this process, the Interstate System should be identified on the map. Next, any sections of other freeways or expressways should be delineated. Additional routes should then be selected to provide continuity through the urban area for the routes already identified and for all other rural principal and minor arterials intercepting the urban boundary. In urban areas under 25,000 population, the principal arterial system will probably consist wholly of routes such as the ones selected above. In those small urban areas over 25,000 population, however, there may exist urban activity centers of regional importance. Where these centers do exist, routes should be added to the principal arterial system so that adequate service is provided.

Next, minor arterial streets should be designated to serve the remaining urban activity centers and to provide adequate areawide circulation. The reasonableness of route spacing should be considered, using the guidelines shown below in Table III-1.

Table III-1--Arterial spacing guidelines

Area type	Arterial spacing
Central business district.....	1/8 - 1/2 mile
Urban (central city except CBD)	1/2 - 1 mile
Suburban.....	1 - 2 miles

Finally, the collector streets should be selected, based on the systems characteristics discussed in Section II, and delineated on the map of the urban area. Remaining streets, of course, will form the local street system.

"Future Year" Classifications.--A functional classification for "future year" system plans in small urban areas can be developed as follows:

1. Develop, in general concept, the pattern of future land uses in presently undeveloped areas within and around the city. Assumptions must be made (realistically) regarding major new commercial, industrial, institutional, and recreational developments as well as residential development. In the absence of a "future year" land use plan, guidance must come from the pattern of land use in the present urban area (particularly from recent growth, if any), for local knowledge of any development proposals, from the pattern of existing road network, from the effect of other transportation facilities, and from an examination of the terrain conditions in the area.

2. Considering the above and the urban boundary criteria discussed on page II-7, delimit the "future year" urban area boundary.

3. Using the latest available functional classification as a base, delineate the principal arterial and minor arterial street networks within the future year urban area boundary. Included in these networks will be projected new facilities based on the land use plan or the assumption developed in (a) above.

4. Evaluate (for reasonableness) the extent of the projected mileage of new facilities developed in (c). Miles of arterials per square mile of area should be comparable to the rate in areas presently developed to a similar land use intensity. This miles-per-square-mile rate for facilities in the area of future urbanization should logically not be higher than the corresponding rate for the present urban area, since the latter includes the densely developed areas of the city.

5. Projecting proposed locations for future collector and local streets in presently undeveloped areas may, in many cases, be impracticable. However, statistical estimates of future collector and local street mileage may be desired, particularly as a basic for projecting maintenance requirements. Statistical indices, such as a street-miles-per-square-mile rate, may be developed, based on existing developments at dwelling unit or population densities similar to that projected for the new area.

6. Evaluate the adequacy of the overall classification plan to serve anticipated future year travel. The following questions, among others, should be considered: Does the pattern of principal arterials (if any) plus minor arterial streets provide adequate continuity for citywide movement? Can anticipated future year capacity requirements be met within developable rights-of-way of the designated network or should additional arterials (one-way couplets, for example) be designated? Would such added arterials, in regard to their impact on the immediate environment, be representative of realistic proposals that might be implemented to satisfy local demand? Has the distinction between arterial and collector streets been properly and consistently defined?

7. Develop the further subclassifications within the principal arterial street classes required to provide connecting links for the rural principal arterial and minor arterial systems as described on page II-15.

CLASSIFICATION PROCEDURES FOR URBANIZED AREAS

Introduction

This subsection of the manual presents a procedure which can be used to develop functionally classified street and highway systems in urbanized areas. No such procedure can be used mechanically or without judgment. Rather, it is intended to serve as a guide, and if proper application is made of the definitions and criteria, the resultant systems will be fully appropriate for this nationwide study and should provide an excellent base for local transportation planning.

It should be mentioned at the outset that the procedures presented in this section are suggested as a logical approach to urban functional classification. They are designed to conform with the needs and capabilities of most of the urbanized areas. For those areas in which all of the procedures outlined here cannot be followed, the suggested methods may still be adhered to as closely as available data permit.

Listed below are the basic steps which comprise the suggested procedure for functional classification in urbanized areas (each step is discussed in the following text):

A. Determine and map the urbanized area boundary.

B. Map the road network.

C. Perform a preliminary classification of the total arterial system.

D. Classify the final arterial system.

E. Classify the principal and minor arterial street systems.

F. Substratify the principal arterial system.

G. Classify collector and local streets.

Classification Procedures

A. Determine and map the urbanized area boundary

The definition of urban area is given on page II-7. Federal-aid urban area boundaries are established in accordance with Volume 4, Chapter 6, Section 3 of the Federal-Aid Highway Program Manual.

B. Map the road network

A base map should be prepared containing the street and highway network within the urbanized area. In most urbanized areas, preparation of such a map will simply involve updating existing maps.

C. Perform preliminary classification of the total arterial system

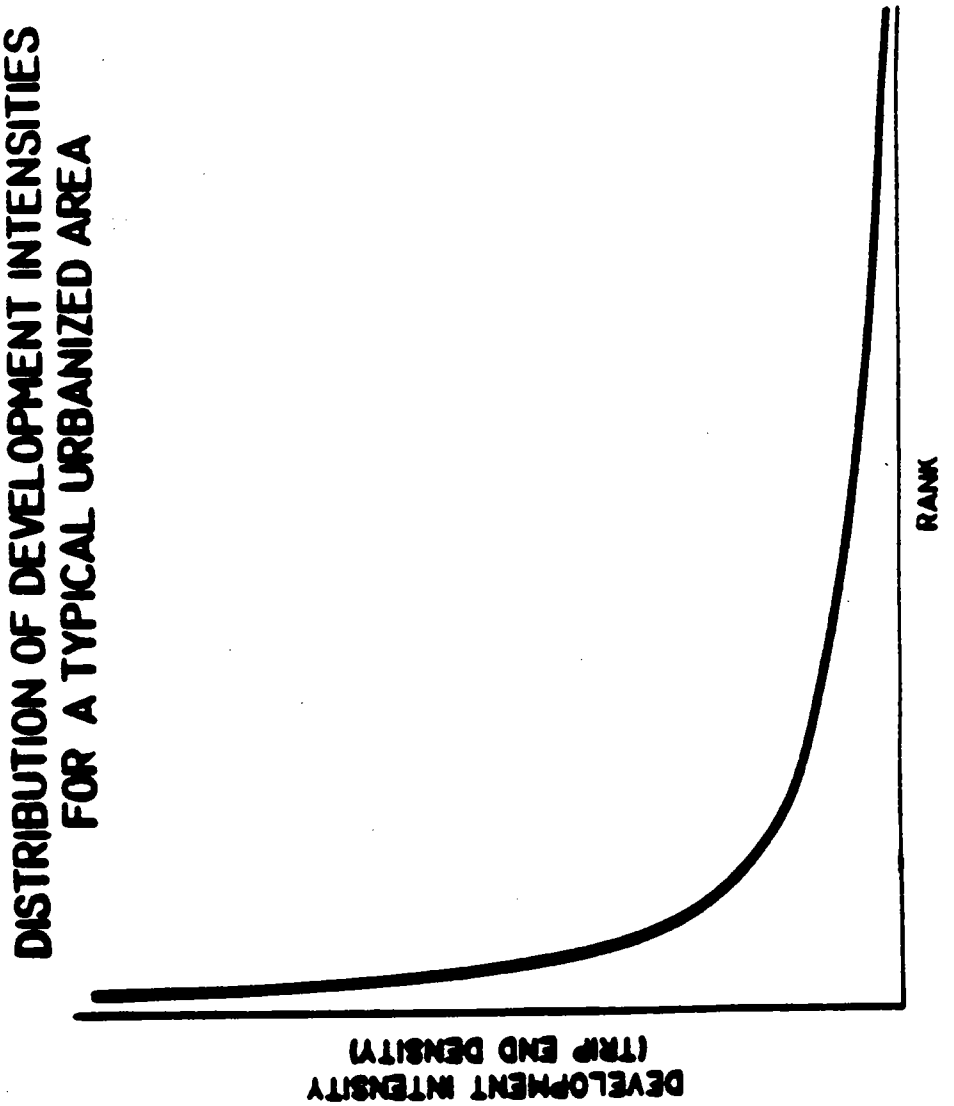
The preliminary classification is directed toward establishing a tentative division between arterials and all other streets and highways, based upon all available criteria. Where the choice between arterial and collector is borderline or unclear, the facility should be included in the preliminary arterial system. Resolution will come with more detailed analysis in the final arterial system classification when additional criteria may be applied.

Functional system criteria are related to trips served, areas served, and characteristics of the facilities themselves. Within this basic framework, specific measures can be identified as being particularly applicable in assigning facilities to predefined functional classes. For urban functional classification, the criteria measures deemed most useful include service to urban activity centers, system continuity, land use considerations, route spacing, trip length, traffic volume, and control of access. Naturally, none of these can be applied independently, or to the exclusion of all others, in developing functional systems. It is hoped that as many of these as are feasible will be considered in arriving at a logical functional classification. The application of these criteria in classifying a preliminary arterial system is described below.

1. Service to urban activity centers

The greater the importance of an urban activity center, in terms of the nature and quantity of travel generated, the wider is its range of trip attraction and, therefore, the greater its need to be served by a higher type system. Some urban activity centers may be evaluated for relative importance by quantitative measures of size and intensity of use, such as number of employees, trip-end density, and the like. In determining the hierarchy of trip generation centers, it may be helpful to consider them in groups arranged according to such measures. These can be plotted from high to low, in the manner shown in Figure III-4. Such an analysis may be useful in identifying the trip generators that should be served by each functional system. Typically, there are comparatively few very large generators in an urbanized area and these should be served by the principal arterial system.

FIGURE III-4


DISTRIBUTION OF DEVELOPMENT INTENSITIES
FOR A TYPICAL URBANIZED AREA
DEVELOPMENT INTENSITY
(TRIP END DENSITY)
RANK

Where urban activity centers of social and economic importance to the area cannot be weighed quantitatively, they should be identified, subjectively ranked, and appropriately served by the principal or minor arterial system as warranted. Subjective comparison of the relative importance of these centers to those of the first type may be helpful.

Centers appropriately served by arterials should generally include traffic generators of regional or community importance. These consist of the business districts of the central city as well as those of satellite communities, shopping centers, recreational facilities which serve larger than purely local areas, transportation terminals, industrial centers, large high-density residential developments, and the like. These travel generators may be considered to be served by arterials if such a facility passes within one-quarter to one mile of the limits of the activity center, depending upon the type of arterial and the size of the generator. All trip generators which warrant arterial service should be located on a suitable map or overlay, identified according to relative importance.

2. System Continuity

The arterial system should be completely integrated, with stub ends occurring only at the urban area boundary (in which case they connect with a rural arterial or a rural collector) or in areas having unusual topographic features, such as sea coasts.

In rare instances, system continuity should not be an absolute constraint for the functional classification of systems. Exceptions could be permitted where long-distance trips end at major centers, such as airports.

3. Land-use considerations

Land use is a primary consideration in functional classification, for the mosaic of existing land use largely governs overall travel patterns, travel density, and street spacing.

The transportation system is a major structural element of the community. It serves as a circulatory system providing travel mobility, but it serves equally as a skeletal system providing a relatively permanent framework which delineates and influences the pattern of land development, and within which residential neighborhoods and other land uses may develop and function. The preservation of neighborhoods, the stabilization of desirable land uses, and the encouragement of orderly development are among the basic considerations in the development of functional street systems.

The concept of streets as a land use is also important in functional classification. In the same manner that industrial activities usually make undesirable neighbors for residential districts, but make suitable neighbors for railroads, so must streets and traffic be viewed in terms of their impact upon as well as service to adjacent land uses. The classification of streets into functional types recognizes this and encompasses, at one extreme, local streets which furnish access to abutting land and discourage through-traffic movement, and at the other extreme, arterials which furnish a primary service to through travel and avoid penetrating identifiable neighborhoods where possible. Establishment of functional street systems and unification of these systems into a balanced network are basic to comprehensive urban planning and must be concurrently accomplished as an integral component of urban planning procedures.

Using suitable overlays on the base transportation network, maps should be prepared which identify all sizeable areas of similar land-use characteristics, such as industrial, commercial, institutional, open space, or residential. Maps such as this are readily available in most urbanized areas in a form requiring little or no additional work.

4. Spacing between routes

The geometric configuration of highway and street systems must be related to the spatial distribution of the activities to be served and to the density of traffic generated. Generally, the more intense the development, the closer the spacing required. In the less dense suburban portions of an urbanized area, neighborhoods tend to be larger than in the more dense central cities. These less dense areas will not require the same close spacing of facilities to serve traffic as the areas closer to the central business district (CBD).

Based upon these considerations Table III-2 presents a general indication of desirable arterial spacing according to type of area. In addition, Figure III-5 provides a measure of theoretical arterial spacing required to serve travel to varying intensities. It is recognized that neither the spacing guidelines included in the table nor the theoretical spacing reflected by the curves in Figure III-5 will apply universally to the spacing of existing arterials. However, they may prove particularly useful in borderline cases where other criteria cannot fully indicate the appropriate functional class of a particular facility.

FIGURE III-5

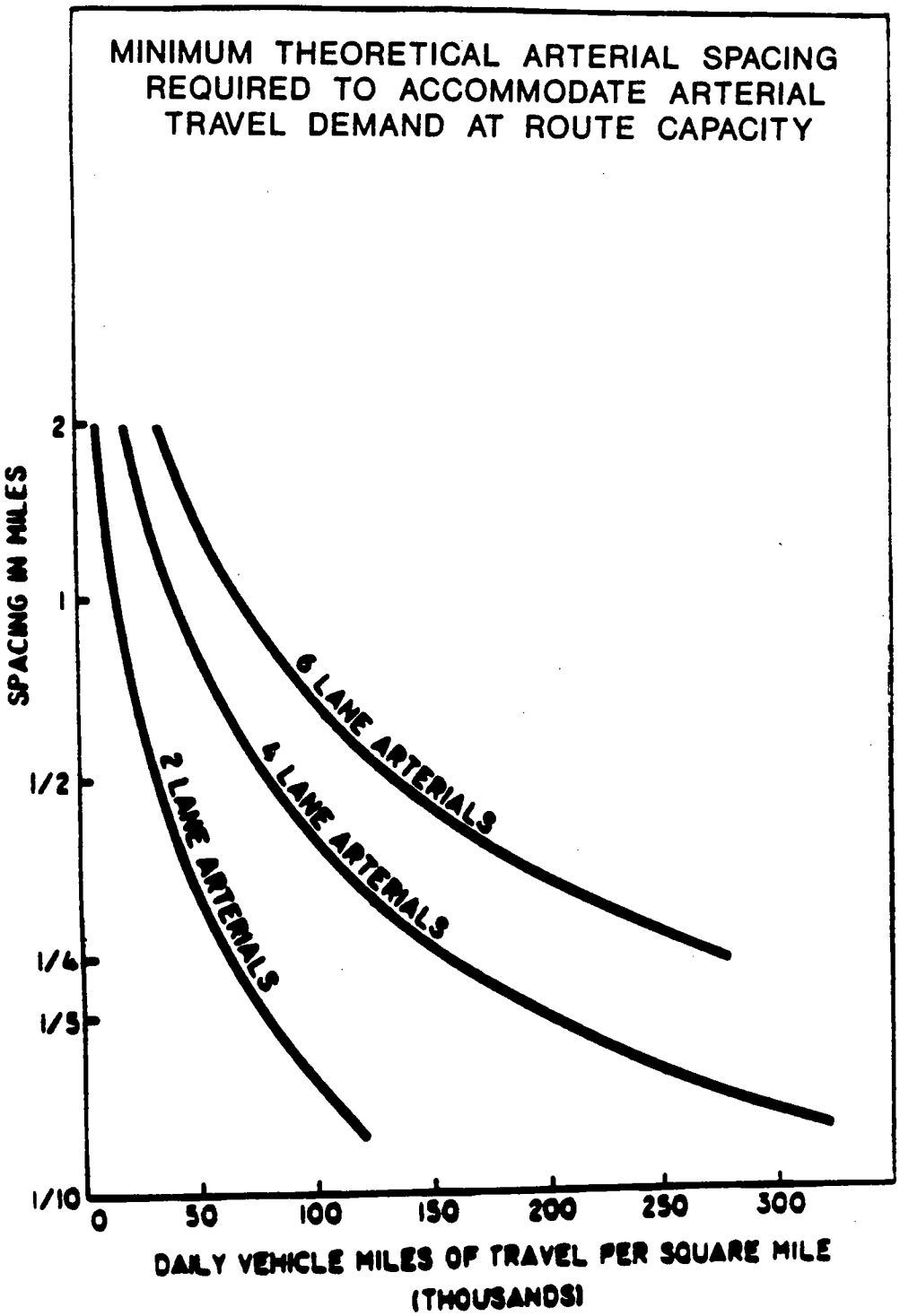

MINIMUM THEORETICAL ARTERIAL SPACING REQUIRED TO ACCOMMODATE ARTERIAL TRAVEL DEMAND AT ROUTE CAPACITY
SPACING IN MILES
2
1
1/2
1/4
1/5
1/10
6 LANE ARTERIALS
4 LANE ARTERIALS
2 LANE ARTERIALS
0
50
100
150
200
250
300
DAILY VEHICLE MILES OF TRAVEL PER SQUARE MILE
(THOUSANDS)

Table III-2 -- Arterial spacing guidelines

Area type	Arterial spacing
Central business district.....	1/8 - 1/2 mile
Urban (central city except CBD)	1/2 - 1 mile
Suburban.....	1 - 2 miles
Lowest density development.....	2 - 3 miles

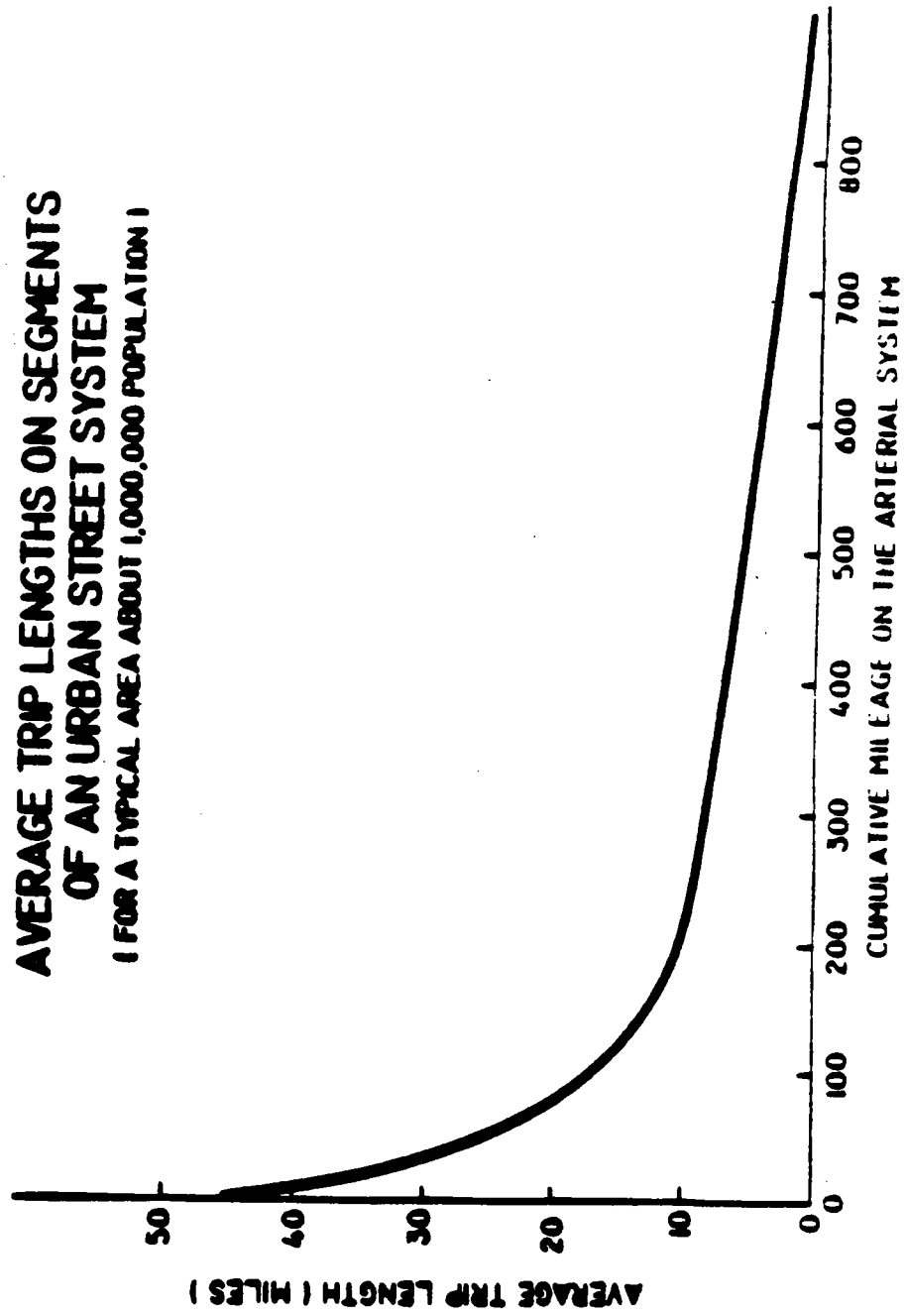
5. Average trip length

A basic assumption in assigning facilities to logical functional groupings is that higher order systems should generally serve the longest trips. Figure III-6 illustrates a characteristic high-to-low ordering of average trip lengths on segments of a highway network in a large urban area. Only comparatively few miles of urban streets and highways serve trips of any great length; a somewhat greater mileage serves trips of moderate length; and a substantial mileage serves comparatively short trips. The approximate break points between these trip-length groupings can suggest possible ranges of average trip length for each of the functional system.

A quantitative measure of average trip length on a facility can be obtained if desired via the traffic assignment process. However, it is also possible to apply this criterion in a generalized way without the benefit of quantitative measurements. This requires a knowledge of the nature of travel served by individual roads. Facilities which serve relatively long trips (including trips passing through the urban area, trips between the suburbs and central city, trips between outlying communities, and long trips occurring within the central city) are likely to be functioning as arterials and should be considered for inclusion in the preliminary arterial system.

An exception in application of the average trip length criterion lies in the existence of outlying minor routes which, by virtue of their distance from the metropolitan center, may carry an unusually high proportion of long trips; indeed, longer average trip lengths than on some principal arterials located closer to the center of the metropolitan area. Consequently, it is necessary to consider trip length within the basic framework of other criteria that reflect the other characteristics of a facility as well as the type of area the facility is in.

FIGURE III-6


AVERAGE TRIP LENGTHS ON SEGMENTS
OF AN URBAN STREET SYSTEM
(FOR A TYPICAL AREA ABOUT 1,000,000 POPULATION)
AVERAGE TRIP LENGTH (MILES)
50
40
30
20
10
0
0
100
200
300
400
500
600
700
800
CUMULATIVE MILEAGE ON THE ARTERIAL SYSTEM

6. Traffic volume

In functional classification, the routes with the highest traffic volumes are likely to be included in the highest type systems, although this is by no means a firm rule. To assist in developing specific volume criteria for an individual urban area, it is suggested that a list of volumes on individual route segments be plotted (from high to low) against the mileage of routes included as illustrated by Figure III-7. Notice that there are usually relatively few miles of the system that carry high volumes and a modest mileage carrying moderate volumes, but that most mileage comprises low-volume routes.

Most high-volume streets and highways in an urban area function as arterials. But there are exceptions, notable in intensely developed areas where high-volume facilities function as collectors, serving traffic movements between local streets and arterials, or providing a high degree of direct access service to abutting property. For example, some roads which border on large traffic generators may carry proportionately high volumes of traffic while functioning as collectors.

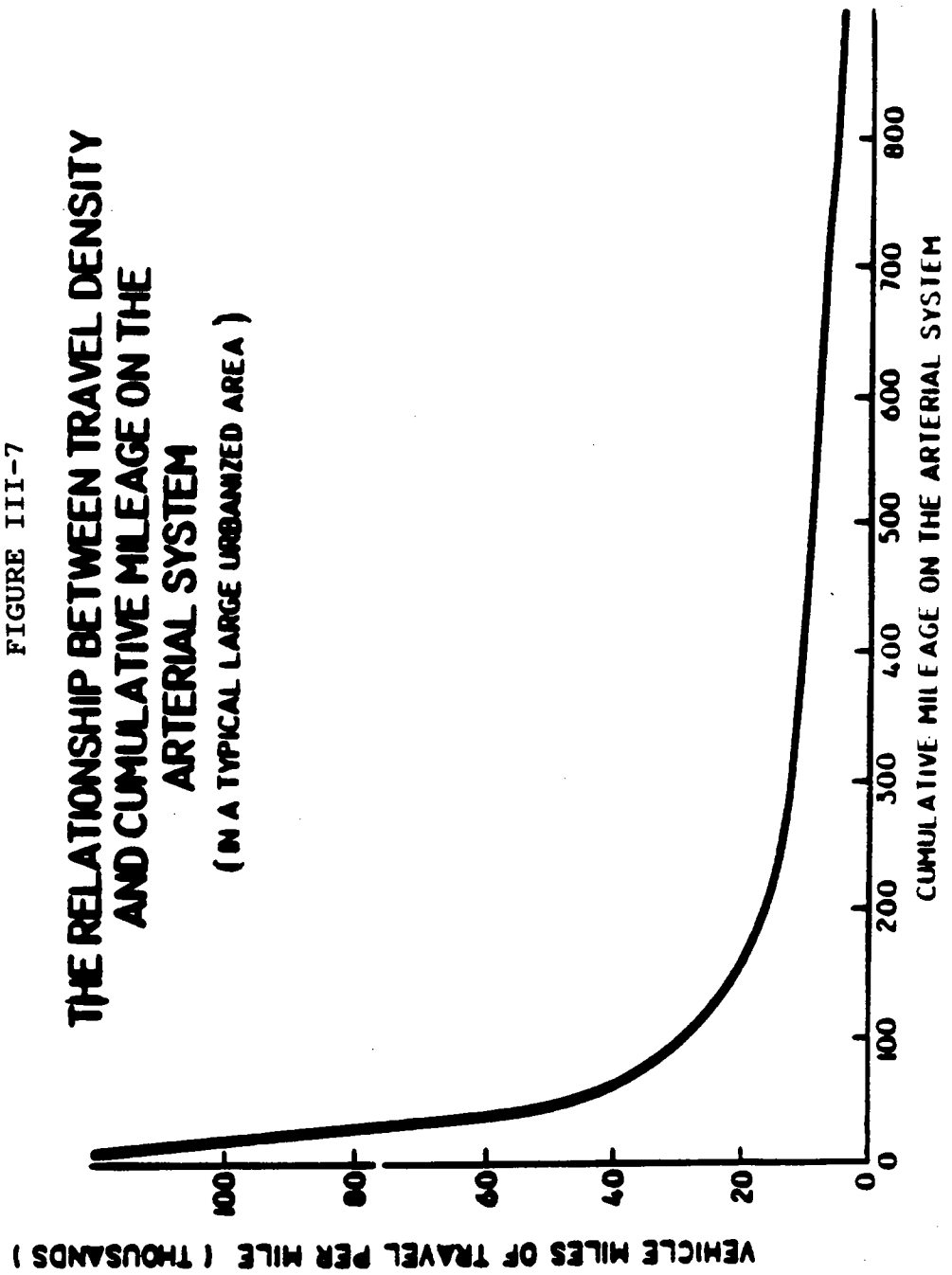
To use the volume criterion as an aid in establishing a preliminary arterial system, it is desirable to have traffic volume data on all segments that probably will be classified as arterials and on all or most facilities which will eventually comprise the "upper" portion of the next lower functional class of roads. This is necessary for determining the approximate volume range in which the break between arterials and collectors occurs (considering the exceptions noted above), as exemplified by the curve in Figure III-7. Traffic volume flow maps as well as a rank order distribution of road segments based upon volume can also assist in the analysis.

It is not intended that traffic counts be made specifically for this analysis. Rather, it is hoped that extensive use will be made of the most recent data already available.

7. Control of access

Control of access is perhaps the easiest criterion to apply, since facilities with full or partial control of access will almost always be in the arterial class. It may therefore be advantageous to delineate these facilities at the very outset, thereby providing for a convenient starting point in defining a preliminary system of arterials.

FIGURE III-7


THE RELATIONSHIP BETWEEN TRAVEL DENSITY AND CUMULATIVE MILEAGE ON THE ARTERIAL SYSTEM
(IN A TYPICAL LARGE URBANIZED AREA)
VEHICLE MILES OF TRAVEL PER MILE (THOUSANDS)
100
80
60
40
20
0
0
100
200
300
400
500
600
700
800
CUMULATIVE MILEAGE ON THE ARTERIAL SYSTEM

8. Vehicle-miles of travel and mileage

The extent of vehicle-miles of travel and system mileage to be included in the preliminary arterial system classification should be on the high side of the values entered in Table II-3. This will be the natural outcome of including in this system all facilities about which serious question remains as to whether they are arterials or collectors. It is logical to include such facilities initially in order that they may be subjected to the more stringent analyses described in step D.

D. Classify the final arterial system

The result of the preceding phase of the urban functional classification procedure should be a first approximation of an arterial system. At this point a reevaluation of the preliminary system is undertaken in order to define a final system of arterials.

The procedure used to determine the final arterial system will be highly dependent upon individual study circumstances. In cases where the preliminary arterial system is judged to be adequate, with relatively few facilities in question as to whether they logically function as arterials or collectors, this phase in the analysis may only involve a refinement of the application of the criteria described in step 'C'. In cases where there are numerous questions regarding the proper functional classification of facilities (arterials versus collectors), professional judgment and vision will be appropriate after considering all criteria and guidelines.

E. Classify the principal and minor arterial street systems

Step 'C' and 'D' were directed toward establishing the total system of arterials in the urban area. The next step is to identify an integrated system of principal arterials, with all remaining arterials designated as minor arterial streets. The principal arterial system, as defined earlier, comprises three categories of facilities: Interstate highways, other freeways and expressways, and other principal arterials. Since the first two of these categories consist of readily identifiable facilities, the primary task described in this step entails the identification of the split between "other" principal arterials and minor arterial streets.

The criteria used in step 'C' for the designation of a total arterial system can be reapplied here to assist in this differentiation between "other" principal and minor arterial streets, as described below.

1. Service to urban activity centers (traffic generators)

In step C-1., all major generators which warrant arterial service were identified and mapped. A breakdown is now required to distinguish between those centers that should be served by the principal arterial system and those that require at least minor arterial street service. A principal arterial is considered to be offering service to a center when direct access is not further than about one-half to one mile from the facility, while for a minor arterial street, the suggested maximum range is from one-quarter to one-half mile.

As mentioned previously, the rank ordering of traffic generators by quantitative and/or subjective criteria can assist in the allocation of functional responsibility. Generally, centers of regional significance should have principal arterial service, and community oriented centers usually should have at least minor arterial street service. The following list can serve as a guide in determining the generators to be served by the principal arterial system:

a). Business districts of the central city(s) as well as those of larger satellite cities located within the urban area.

b). Important air, rail, bus, and truck freight terminals.

c). Regional retail shopping centers (those usually containing at least one major department store and generally selling goods, apparel and furniture, as opposed to convenience type of shopping goods).

d). Large colleges, hospital complexes, military bases, and other institutional facilities.

e). Major industrial and commercial centers.

f). Important recreation areas such as regional parks, beaches, stadiums, and fairgrounds.

2. System continuity

The "building" of functional systems beginning with the principal arterial system should form, at the conclusion of each functional system addition, an integrated, continuous network throughout the area. Thus, the principal arterial system will be an integrated system which is continuous throughout the urbanized area (except as noted on page III-15) and which also provides for statewide continuity of the rural arterial systems. The combined principal and minor arterial street systems will also form an integrated system. Likewise, when collectors, and finally locals, are added to the higher order systems the combinations at each stage are to be integrated systems. It should be understood that the minor arterials, collectors, and locals need not be integrated systems by themselves, but only in combination with the previously designated higher order system.

3. Land use considerations

Arterials can serve as buffers between incompatible land uses, and conversely, should avoid penetration of residential neighborhoods. Similarly, the configuration of the arterial system as a whole has a significant impact on land development policies and practices, although the magnitude of such impact is probably correlated with the relative significance of the arterial. In the extreme, controlled-access facilities serve best in separating land uses and generally have the most noticeable impact on land use.

A pertinent land use consideration in the classification process is that of the degree of access to abutting land. The land access function of principal arterials is entirely subordinate to their primary function of carrying traffic not destined to land adjacent to the facility. Minor arterial streets, on the other hand, have a slightly more important land access function, though even for this class of facilities this is a secondary consideration.

4. Spacing between routes

It is difficult to define spacing criteria to assist in separating principal from minor arterials, since this factor has less bearing upon the differences that mark these two classes of roads than some of the other measures described in this section. In an ideal sense, spacing between principal arterials should be greater than spacing between minor arterial streets. Normally, minor arterial streets will be located between principal arterials.

In the larger urbanized areas, the spacing of principal arterials may vary from less than one mile in the highly developed central business area to five miles or more in the sparsely developed suburban fringes. However, the nature of the land development pattern, and the associated travel patterns, in most urban areas will preclude the unqualified application of such an idealized rule.

5. Average trip length

Principal arterials should, as a general rule, serve trips which are significantly longer than those that are carried on the minor arterial street system. A qualitative (subjective) measure of trip lengths served by facilities is possible from a knowledge of the existing street and highway system and the routes generally used for long trips.

6. Traffic volume

The traffic volume criterion can be used here in a fashion similar to the procedure described in step C-6. However, a note of caution is warranted since the division between principal and minor arterials will be less subject to decision according to the amount of traffic carried on a facility than the split between all arterials and collectors. Because traffic volumes in the outlying portions of an urbanized area are generally lower than in the more densely populated central areas, the volume on a minor arterial street in the central city may be greater than the volume on a principal arterial in a suburban area. Thus, the volume of traffic carried by a facility should not be the controlling criterion in determining the proper system classification for a street, although it may be an important consideration.

7. Control of access

The access-control criterion is perhaps the most straight-forward to apply. Almost all facilities with full or partial control of access will fall within the principal arterial category. Partial access control is defined, for the purposes of this study, as the exercise of police power to limit access to a highway from abutting land to specified and controlled points. In a few instances such facilities may be determined to be functioning as minor arterial streets.

8. Vehicle-miles of travel and mileage

Upon completing the functional classification of arterials into the two basic categories, principals and minors, the cumulative vehicle-miles of travel carried by each class of facility in terms of cumulative mileage should be determined. These values should be compared with the general guidelines presented in Table II-3. While exceptions are to be expected in a number of urban areas, an attempt should be made to describe the reasons for them where they do occur. If no substantive causes can be identified, consideration ought to be given to a re-examination of the functional classification as performed to this point.

A typical plot for an urbanized area of cumulative urban street mileage versus cumulative vehicle miles served is shown in Figure III-8.

F. Substratify the principal arterial system

Completion of step 'E' should produce a finalized breakdown between arterials and other facilities, as well as a stratification of arterials into principals and minors. The principal arterial system should be further divided into the three subcategories of Interstate highways, other freeways and expressways, 1/ and other principal arterials. (Those facilities which are currently providing continuity between completed portions of the Interstate System should be designated as either other freeways and expressways or other principal arterials, as the case may warrant.)

At this point in the development of a functionally classified system connecting links should be identified to provide continuity for rural arterials which intercept the urban area boundary.

1/ The designation of expressways should be in accordance with the American Association of State Highway and Transportation Officials (AASHTO) definition.

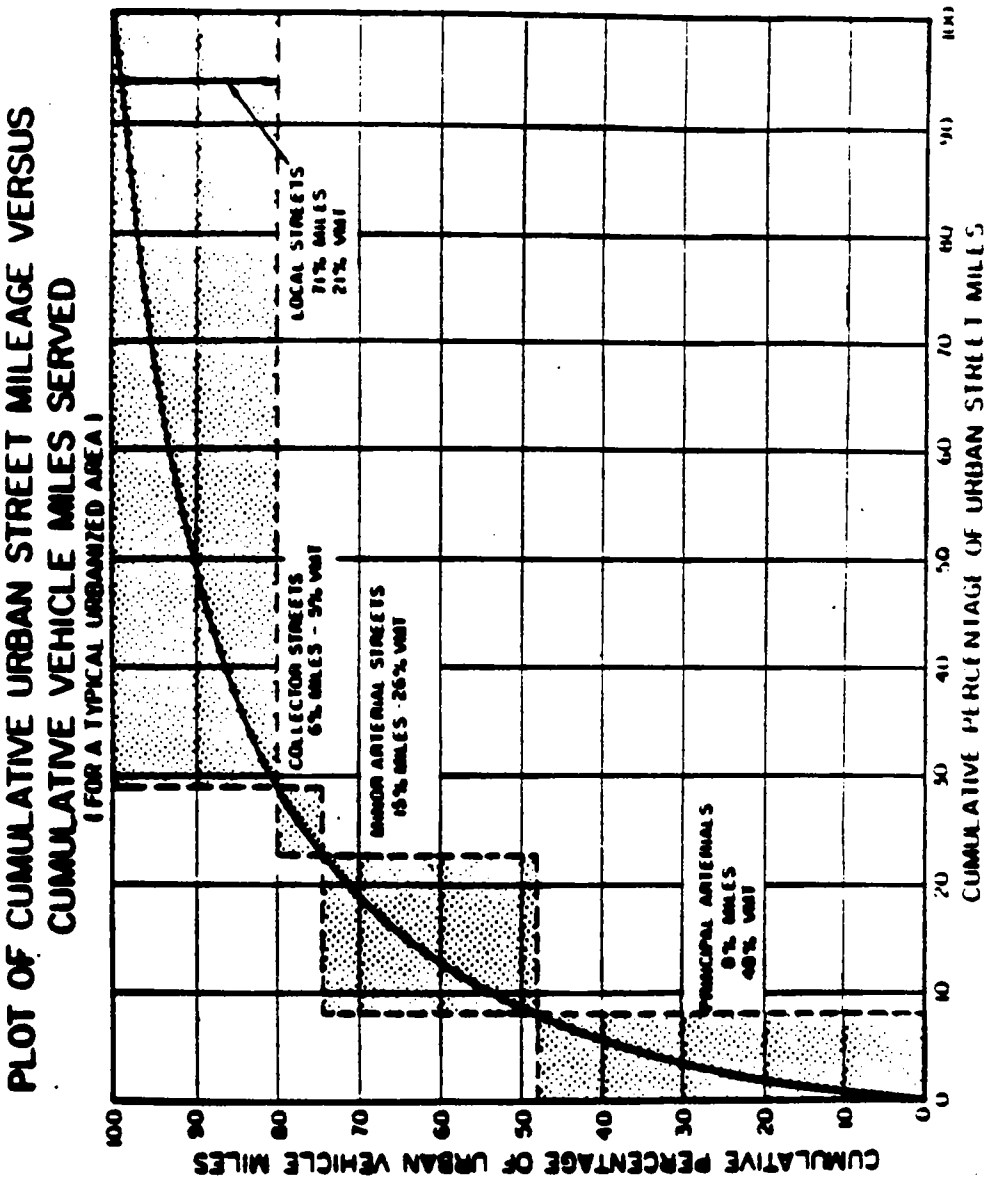

PLOT OF CUMULATIVE URBAN STREET MILEAGE VERSUS
CUMULATIVE VEHICLE MILES SERVED
(FOR A TYPICAL URBANIZED AREA)
CUMULATIVE PERCENTAGE OF URBAN VEHICLE MILES
CUMULATIVE PERCENTAGE OF URBAN STREET MILES
LOCAL STREETS
COLLECTOR STREETS
MINOR ARTERIAL STREETS
PRINCIPAL ARTERIALS

FIGURE III-8

G. Classify collector and local streets

With the designation of the arterial system, the remaining streets in the urban area will comprise those facilities which function as collectors and locals. It will be necessary to shift the scale of the analysis at this point in order to identify these classes of roads in terms of the individual streets which are in each functional category, the total amount of travel occurring on these classes of streets, and the total mileage they represent. Pertinent steps in the procedures described above, and the definitions and criteria presented earlier, should be applied to the fullest extent possible.

The basic consideration here is that collector streets, which may have a relatively important land access function, serve primarily to funnel traffic between local streets, where the land access function is dominant, and the arterial system, where service to through traffic is of primary importance. In order to bridge this gap between locals and arterials, collectors must, and do, penetrate identifiable neighborhoods.

With the identification of collector streets, all remaining facilities which have not been designated as arterials or collectors will necessarily fall within the local category. The extent of the collectors and locals, as measured by cumulative vehicle-miles of travel and mileage, should be computed with the generalized values presented in Table III-3. Where significant differences exist, they should be noted and discussed.

"Future Year" Classifications

A functional classification for "future Year" system plans in urbanized areas can be developed as follows:

1. Develop, in general concept, the pattern of future land uses in presently undeveloped areas within and around the city. Assumptions must be made (realistically) regarding major new commercial, industrial, institutional, and recreational developments as well as residential development. In the absence of a "future year" land use plan, guidance must come from the pattern of land use in the present urban area (particularly from recent growth, if any), from local knowledge of and development proposals, from the pattern of existing road network, from the effect of other transportation facilities, and from an examination of the terrain conditions in the area.

2. Considering the above and the urban boundary criteria discussed on page II-7, delimit the "future year" urban area boundary.

3. Using the latest available functional classification as a base, delineate the principal arterial and minor arterial street networks within the future year urban area boundary. Included in these networks will be projected new facilities based on the land use plan or the assumption developed in (1) above and future systems plans developed by the urban planning process.

4. Evaluate (for reasonableness) the extent of the projected mileage of new facilities developed in (3). Miles of arterials per square mile of area should be comparable to the rate in areas presently developed to a similar land use intensity. This miles-per-square-mile rate for facilities in the area of future urbanization should logically not be higher than the corresponding rate for the present urban area, since the latter includes the densely developed areas of the city. Attention should be given to providing an adequate limited access system for area mobility. In addition, consideration should be given to providing good intermodal connectivity.

5. Projecting proposed locations for future collector and local streets in presently undeveloped areas may, in many cases, be impracticable. However, statistical estimates of future collector and local street mileage may be desired, particularly as a basic for projecting maintenance requirements. Statistical indices, such as a street-miles-per-square-mile rate, may be developed, based on existing developments at dwelling unit or population densities similar to that projected for the new area.

6. Evaluate the adequacy of the overall classification plan to serve anticipated future year travel. The following questions, among others, should be considered: Does the pattern of principal arterials plus minor arterial streets provide adequate continuity for areawide movement? Are there sufficient limited access facilities to provide the proper channelization of trips? Does the proposed functional classification adequately support the intermodal transportation plan? Can anticipated future year capacity requirements be met within developable rights-of-way of the designated network or should additional arterials (one-way couplets, for example) be designated? Would such added arterials, in regard to their impact on the immediate environment, be representative of realistic proposals that might be implemented to satisfy local demand? Has the distinction between arterial and collector streets been properly and consistently defined?

7. Develop the further subclassifications within the principal arterial street classes required to provide connecting links for the rural principal arterial and minor arterial systems as described on page II-15.